

**Analysis of the Effects of Selected  
Enclosure and HVAC System Operation  
Parameter Variations on  
the Building Thermal Loads**

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## ABSTRACT

### Analysis of the Effects of Selected Enclosure and HVAC System Operation Parameter Variations on Building Thermal Loads

Steven S. Avram

Carrier Opcost program is frequently used by environmental and control system designers and contractors in the Montreal area to determine building energy requirements and for the initial cooling and heating equipment capacity determination. Due to the proprietary nature of this program, the designer has limited information to assess the results.

In this report, the effects of variations of selected enclosure and environmental control system operation parameters on the thermal loads of a commercial building in Montreal, are determined through a case study using the Carrier Opcost program. Such an analysis will aid the designer to determine which enclosure and system operation alternatives to consider, for a cost and energy effective design.

The effects of the variations of these parameters on the peak cooling loads are found to be negligible (based on the case study). The corresponding effects on the peak heating loads are found to be significant. In consequence, for similar applications of this program, the input choices for the peak heating load calculations should be carefully evaluated.

## ACKNOWLEDGEMENTS

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### List of Symbols

A	surface area
A <sub>w</sub>	wall area
A <sub>g</sub>	glazed area
A <sub>r</sub>	roof area
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
Btu	British Thermal Units
CFM	cubic feet per minute
CLF	cooling load factor (dimensionless)
(CLF) <sub>eqp</sub>	cooling load factor for equipment
(CLF) <sub>lite</sub>	cooling load factor for lights
CLTD	cooling load temperature difference
db	dry bulb temperature
ΔT	temperature difference
ΔW	humidity ratio difference (pounds of water vapour per pound of dry air)
F	degrees Fahrenheit
F <sub>2</sub>	floor heat loss coefficient
hr	hour
(HG) <sub>eqp</sub>	sensible heat gain from equipment
(HG) <sub>ps</sub>	sensible heat gain from occupants
(HG) <sub>pl</sub>	latent heat gain from occupants
HVAC	heating, ventilating and air conditioning

kW	kilowatt
lbm	* pound mass
Np	number of people in space
NE	north east exposure
NW	north west exposure
P	perimeter or exposed edge of floor
QC	transmission heat gain
QeqpL	latent equipment heat gain
QeqpS	sensible equipment heat gain
QeqpT	total equipment heat gain
QFH	transmission heat loss through the floor
QGC	heat gain through glazing
QGH	heat loss through glazing
QH	transmission heat loss
(Qinf)LC	latent heat gain due to infiltration
(Qinf)LH	latent heat loss due to infiltration
(Qinf)SC	sensible heat gain due to infiltration
(Qinf)SH	sensible heat loss due to infiltration
Qint	internal loads
QLC	latent cooling load
QLH	latent heating load
QLite	heat gain from lights
QPL	latent heat gain from people
QPS	sensible heat gain from people
QPT	total heat gain from people

$Q_{RC}$	heat gain through the roof
$Q_{RH}$	heat loss through the roof
$Q_{SC}$	sensible cooling load
$Q_{SH}$	sensible heating load
$Q_{Sol}$	solar heat gain
$Q_{TC}$	transmission heat gain
$Q_{TH}$	transmission heat loss
$Q_{TPC}$	total peak cooling load
$Q_{TPH}$	total peak heating load
$(Q_{vent})_{LC}$	latent heat gain due to ventilation
$(Q_{vent})_{LH}$	latent heat loss due to ventilation
$(Q_{vent})_{SC}$	sensible heat gain due to ventilation
$(Q_{vent})_{SH}$	sensible heat gain due to ventilaiton
$Q_{WC}$	heat gain through walls
$Q_{WH}$	heat loss through walls
$RH$	relative humidity (%)
$SC$	shading coefficient (dimensionless)
$SHGF$	maximum solar heat gain factor
$U$	thermal transmittence
$VAV$	variable air volume (dimensionless)
$V_{vent}$	rate of ventilation air flow
$V_{inf}$	rate of infiltration air flow
$W$	watts
$wb$	wet bulb

## Chapter 1

### Introduction

## CHAPTER 1

### 1.0 Introduction

Various computer assisted methods for the evaluation of cooling and heating loads of buildings, are now commonly used by designers, contractors, and energy conservation specialists in the construction industry. Several surveys of the available computer programs for building load calculations have been published [1,2]. The available load calculation programs are mostly proprietary (source programs are not available for public scrutiny)[2].

Among the existing programs (for micro-computer applications) the Carrier Opcost program [3] is most frequently used by contractors and consultants in the building industry in the Montreal metropolitan area. This observation is based on the author's experience (for over ten years) in this industry. The reasons for the frequent use of this program, are easy access, no usage cost and its ability to calculate cooling and heating loads as well as the energy consumption of a building. In addition, this program [3] is structured to

minimize the time required for the preparation of input data.

For energy effective design of buildings, it is necessary to evaluate the effects of variations of the enclosure parameters (such as the thickness of the insulation, type of glazing, type of construction, etc.) and the indoor environmental control system operation parameters (such as temperature setbacks and set-ups, system shut-off during unoccupied periods, and lighting intensity) on the building thermal loads. When a proprietary program is used for such evaluations, due to limited documentation on the program structure provided by its developer, the user may not be able to justify the results provided by the program.

The objective of this study is to evaluate the effects of variations of the input parameters of the program [3] on the computed peak thermal loads (cooling and heating) and to compare the results from this method with those calculated by the standard manual methods [4,5], so that the users may have a better understanding of the program results.

A description of the building is given in Chapter 2. In Chapter 3, the standard methods for calculations of cooling and heating loads are discussed. A description of the Carrier Opcost program is presented in Chapter 4. Twelve variations of the enclosure and system parameters (inputs) were developed from the program and are summarized in Appendix 1. An analysis of the results, including comparisons with the results from the standard manual methods are presented in Chapter 5. Conclusions are outlined in Chapter 6.

A flow chart of the methodology used in this study is shown in Fig. 1.



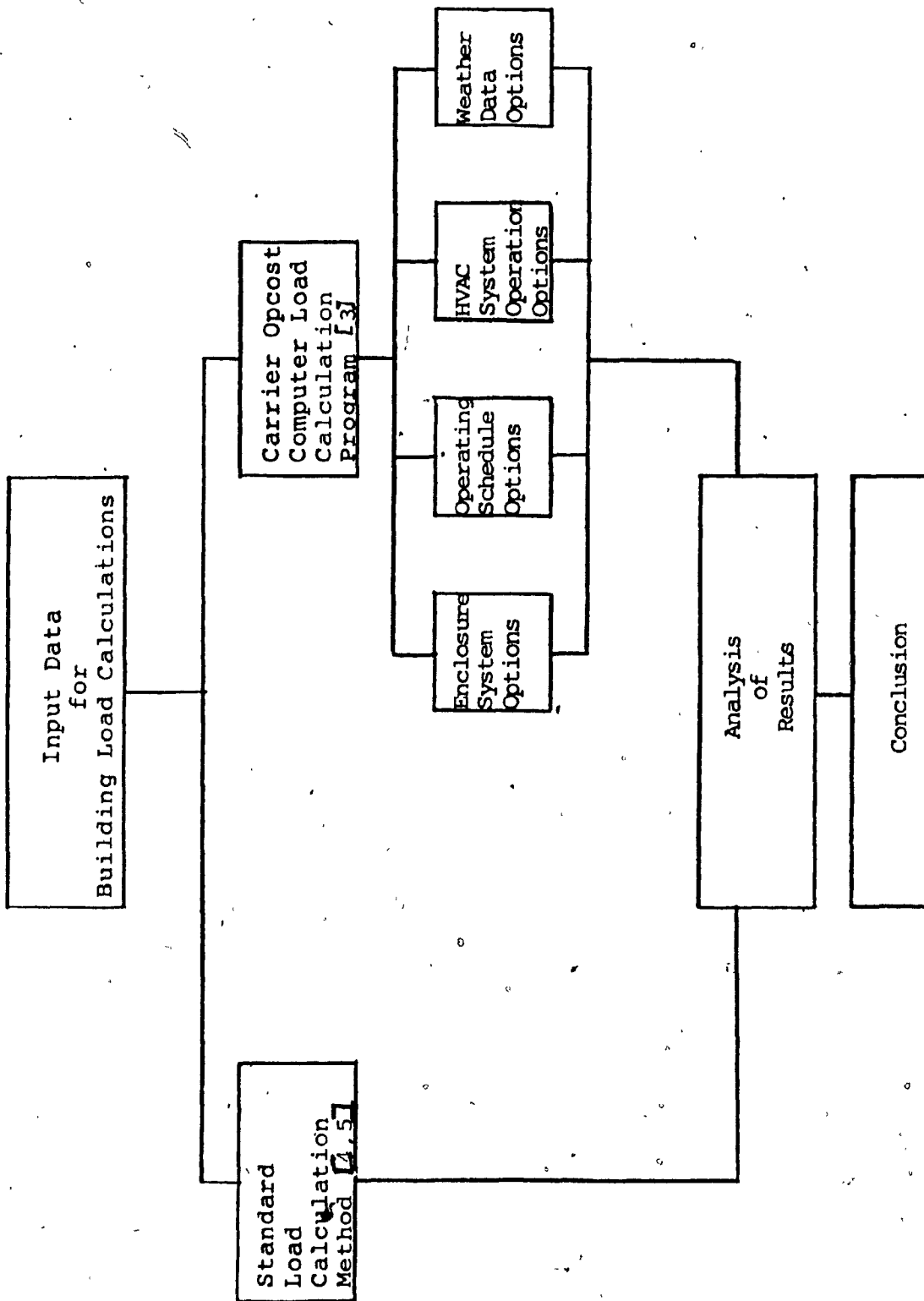


Fig. 1 Flow Chart of the Methodology of Development for this Project

## Chapter 2

### Building Description and Specifications

## CHAPTER 2

### 2.0 Building Description and Specifications

The building used in this case study is a low rise office building located in Montreal, Canada, consisting of three floors; the two top floors are used for office work, and the ground floor contains some commercial space, in addition to offices. Typical floor plans for the building are shown in Fig. 2 and the elevations are shown in Fig. 3. An exterior wall section detail is shown in Fig. 4 and for a glazing detail, see Fig. 5.

Heating for the building is provided by single phase, standard watt density (250W/ft.length), perimeter electric baseboard heaters installed along the outside walls, and the cooling is done by a rooftop air conditioning system, with constant conditioned air supply air volume.

Recessed fluorescent fixtures are used for lighting.

The general office space includes the typical assortment of office equipment found in modern office

buildings. The nature of the tenancy includes law firms and insurance brokers. The commercial space is occupied by a variety store on the ground floor having the same operating schedule as the other tenants.

The normal occupancy schedule is as follows:

Weekdays	8:30 a.m. - 5:00 p.m.
Saturdays (20% occupancy)	9:00 a.m. - 1:00 p.m.
Sundays	Closed

A summary of the major building specifications are shown in Table 1.

Table 1

Building Specifications

Summary of Building Specifications

Location : Montreal  
Total floor area : 13,430 ft<sup>2</sup>  
Number of floors : 3 (no basement)  
Type of occupancy: Private and general offices,  
commercial units

Construction Details

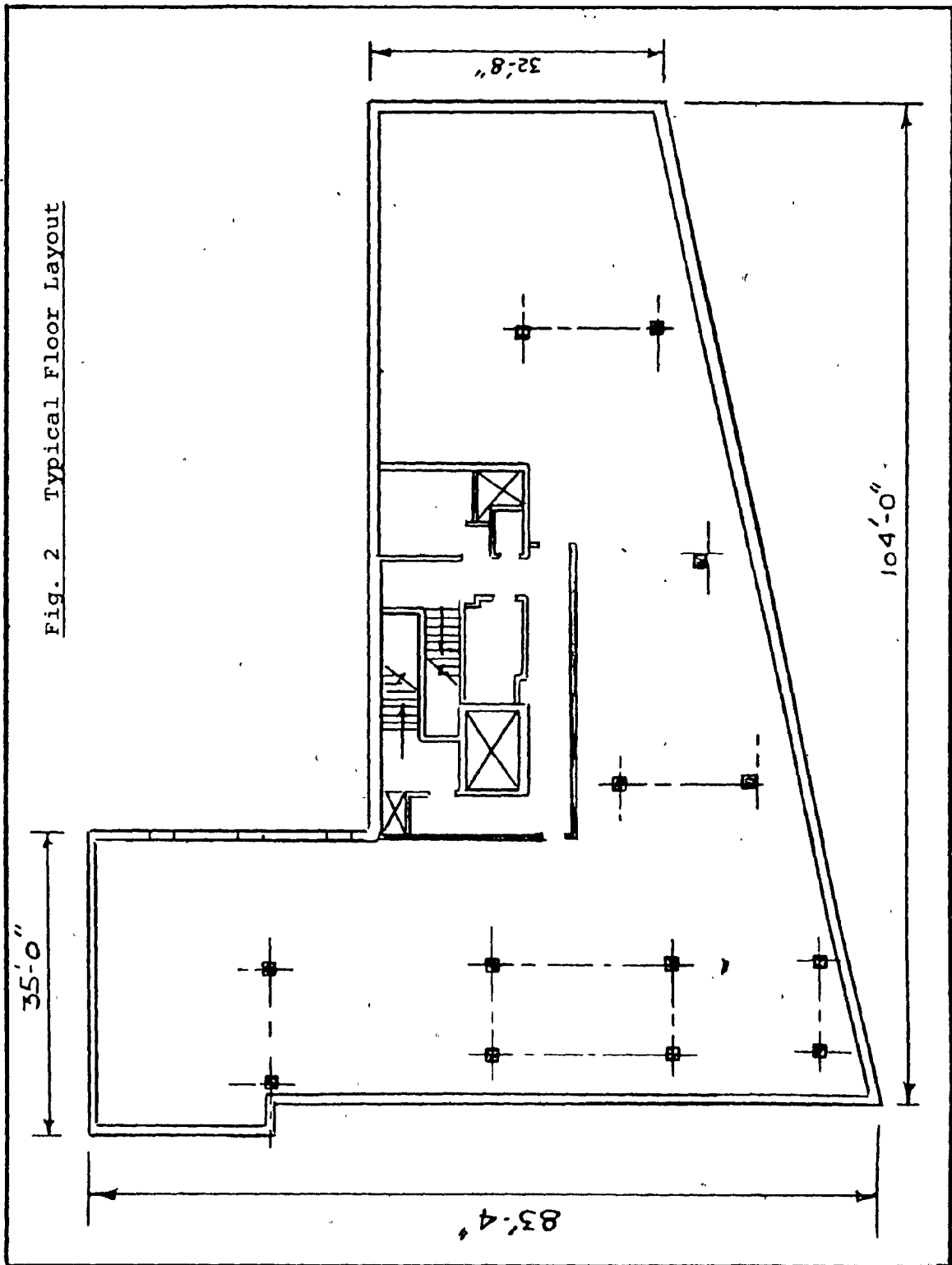
Envelope : See Fig. 4  
Glazing : See Fig. 5  
Roof : 4 ply built up asphalt and gravel  
on concrete deck  
Ceilings : Suspended acoustical 2 ft. x 4 ft. tiles  
on T-bar tracks

Environmental Design Conditions (Ref. 4)

Heating : Outdoor design temperature: - 16°F  
Indoor design temperature : 72°F  
Normal degree days [7] : 4525  
Cooling : Outdoor design temperature: 88°F db  
and: 73°F wb  
Indoor design temperature : 76°F  
and: 50% RH

Cooling is provided by a rooftop, constant volume air conditioning unit.

Lighting : Fluorescent, recessed, fixtures  
1.75 W/ft<sup>2</sup>



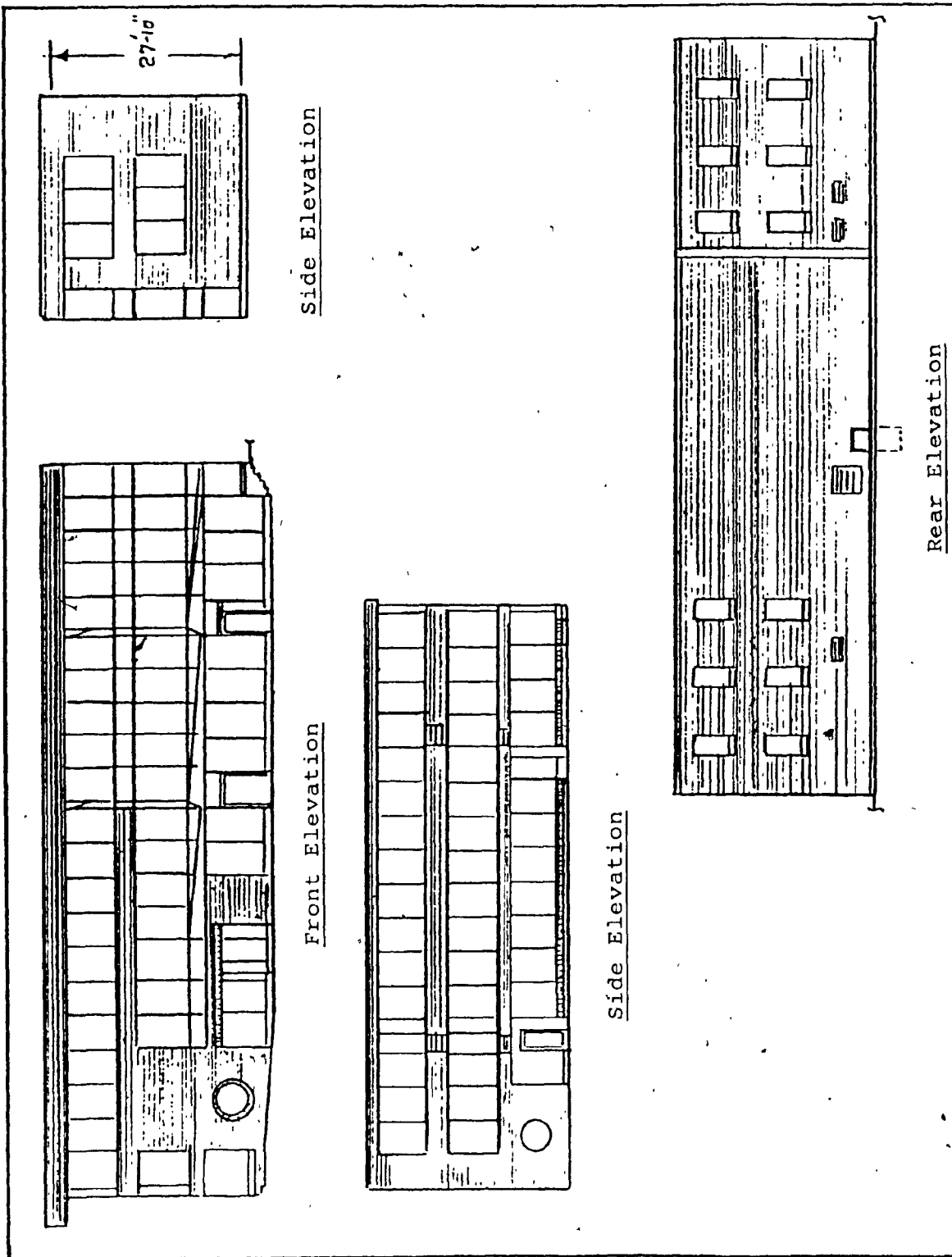
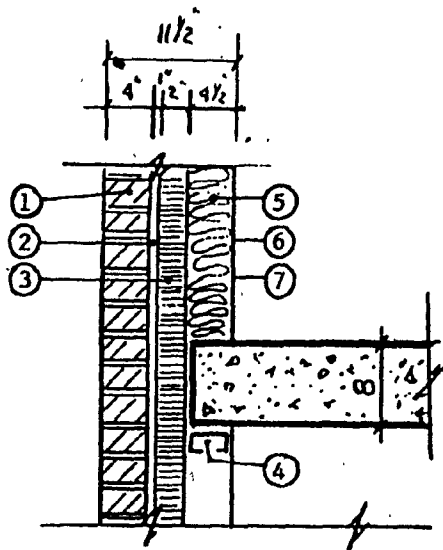


Fig. 3 Building Elevations



- 1 - 4" face brick with tie backs
- 2 - 1" air space
- 3 - 2" rigid fiberglass  
asphalt impregnated
- 4 - 3 5/8" steel studs
- 5 - 3" fiberglass batts
- 6 - 6 mil. polyethyle
- 7 - 1/2" gyproc finish

Fig. 4 Typical Exterior Wall Detail



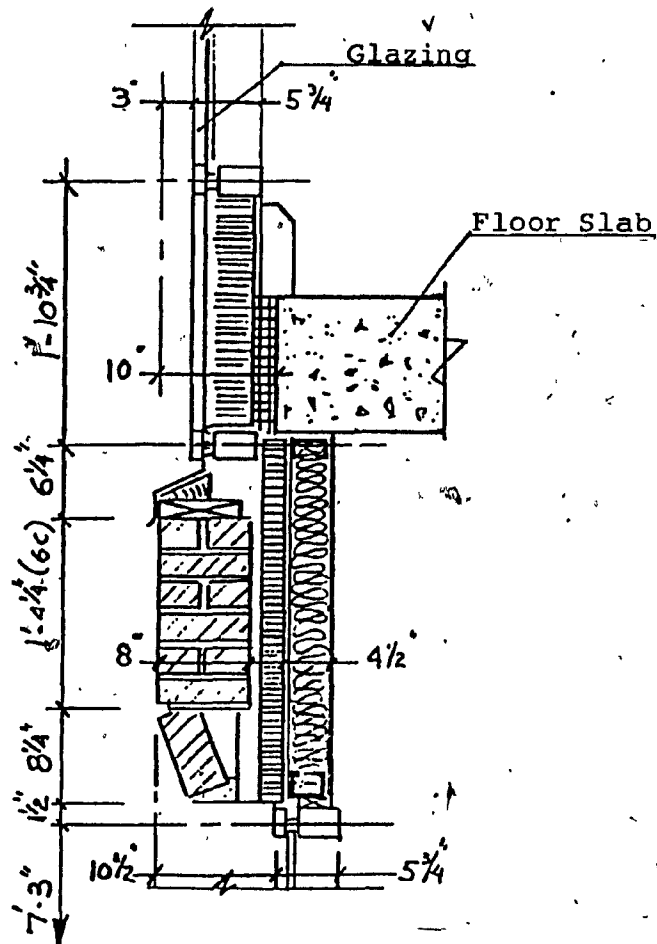


Fig. 5 Typical Glazed Exterior Wall Detail

## Chapter 3

### Cooling and Heating Load Calculations Procedure (Standard Manual Method)

## CHAPTER 3

### 3.1 Cooling and Heating Load Calculations Procedure (Standard Method [4,5])

In this chapter, a description of the cooling and heating load calculation methods recommended by A.S.H.R.A.E. [4,5] and the results obtained, are presented. The results obtained from these calculations are used as the basis for comparison with the results from the computer assisted method [3].

### 3.2 Description of the Building Cooling Load Calculation Method

The building cooling load is comprised of the following separate but interrelated components:

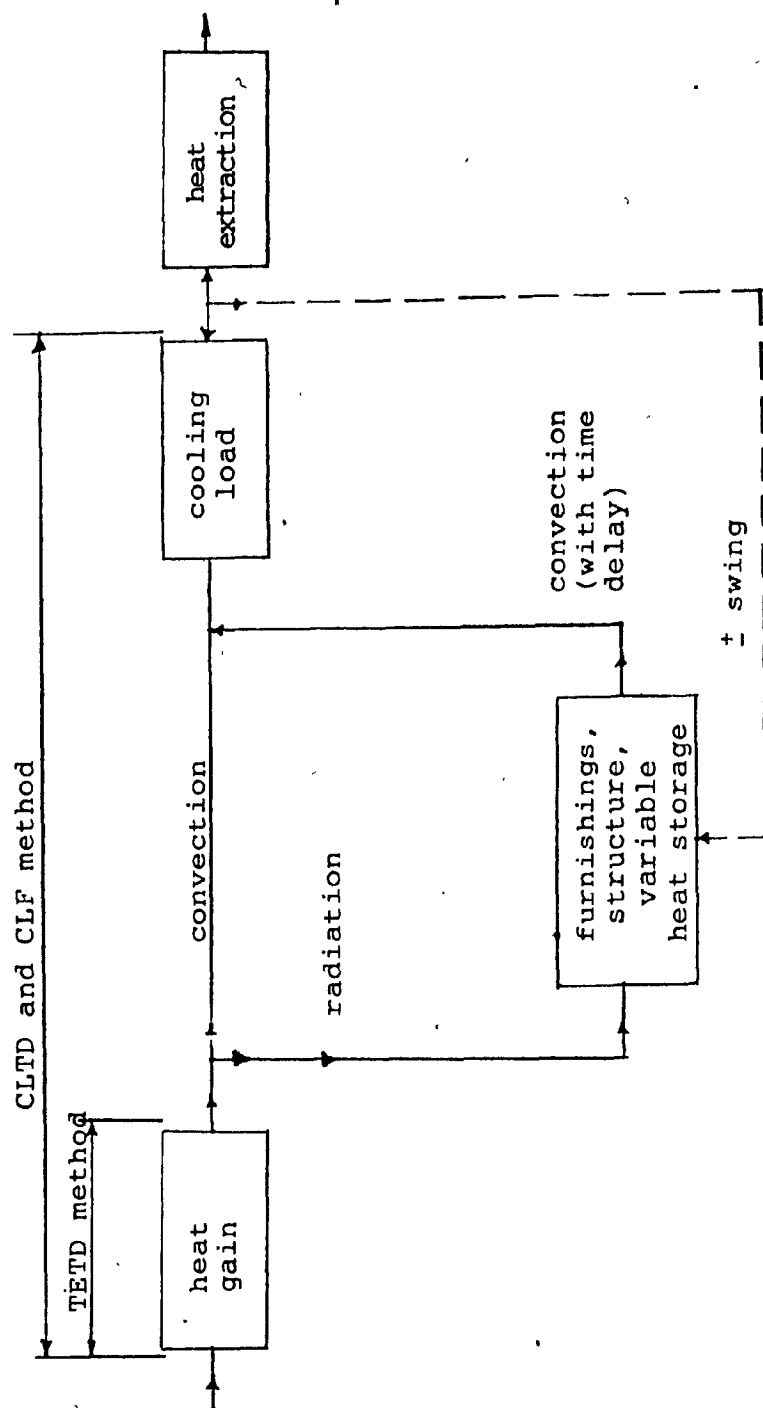
1. space heat gain
2. space cooling load
3. space heat extraction rate

The space heat gain is the instantaneous rate of heat gain into the space, consisting of heat conduction

through exterior walls and roof, solar radiation through transparent surfaces, heat conduction through interior partitions, ceilings and floors, heat generated within the space by occupants, lights and appliances, heat transfer rate as a result of ventilation and infiltration of outdoor air.

Space cooling load is the rate of heat removal from the space in order to maintain constant space temperature. The cooling load may not be equal to the instantaneous space heat gain due to the thermal storage effect illustrated in Fig. 6. The space cooling load calculations are performed in accordance with the CLTD and CLF factors described in reference [5].

• Space heat extraction rate differs from the space cooling load due to the temperature fluctuations in the space as a result of the heat gain and heat extraction rates which may not be equal, and the effects of the building thermal mass.



CLTD: cooling load temperature difference  
 CLF: cooling load factors  
 TETD: total equivalent temperature differential

Fig. 6 Illustration of Thermal Storage Effect in Buildings [5]

### 3.3 Summary of the Cooling Load Calculation Method [5]

The cooling load calculations method is performed for the following load components.

#### 3.3.1 Transmission Load ( $Q_{TC}$ )

The transmission load consists of the heat gains through the roof ( $Q_{RC}$ ), walls ( $Q_{WC}$ ), and glazing ( $Q_{GC}$ ). The total transmission load ( $Q_{TC}$ ) may be expressed as follows:

$$Q_{TC} = Q_{RC} + Q_{WC} + Q_{GC} \quad (1)$$

The transmission load components in equation 1 are calculated as follows:

$$Q_C = U \cdot A \cdot (CLTD) \quad (2)$$

where:

$Q_C$  = transmission heat gain due to roof, walls, glazing or floor; (Btu/hr) or (kW).

$U$  = Thermal transmittance obtained from Ref. [8]; (Btu/hr·ft<sup>2</sup>·F) or (W/(m<sup>2</sup>·K)).

$A$  = corresponding heat transfer surface area; (ft<sup>2</sup>) or (m<sup>2</sup>).

(CLTD) = cooling load temperature difference obtained from Ref [8]; (F) or (K).

### 3.3.2 Solar Load

The solar load represents the space heat gain due to radiation from the sun. The solar load component ( $Q_{Sol}$ ) is expressed as follows:

$$Q_{Sol} = A(SC)(SHGF)(CLF) \quad (3)$$

where:

$Q_{Sol}$  = solar heat gain (Btu/hr) or (kW)

$A$  = the corresponding heat transfer surface area; (ft<sup>2</sup>) or (m<sup>2</sup>).

(SC) = the shading coefficient for combination of type of glass and type of shading obtained from Ref [9].

(SHGF) = maximum solar heat gain factor for specific orientation of surface, latitude and month obtained from Ref. [10]; (Btu/(hr·ft<sup>2</sup>)) or (W/m<sup>2</sup>).

(CLF) = cooling load factor of glass obtained from Ref. [11].

### 3.3.3 Internal Load

The internal load consists of the heat gains due to lights ( $Q_{\text{Lite}}$ ), people ( $Q_{\text{PT}}$ ), equipment ( $Q_{\text{eqPT}}$ ) and is expressed as follows:

$$Q_{\text{int}} = Q_{\text{Lite}} + Q_{\text{PT}} + Q_{\text{eqPT}} \quad (4)$$

$$Q_{\text{Lite}} = (W)_{\text{Lite}} \cdot (CLF)_{\text{Lite}} \quad (5)$$

$$Q_{\text{PT}} = Q_{\text{PS}} + Q_{\text{PL}} \quad (6)$$



$$Q_{PS} = N_p \cdot (HG)_{PS} \quad (7)$$

$$Q_{PL} = N_p \cdot (HG)_{PL} \quad (8)$$

$$Q_{eqPT} = Q_{eqPS} + Q_{eqPL} \quad (9)$$

$$Q_{eqPS} = (HG)_{eqp} \cdot (CLF)_{eqp} \quad (10)$$

where:

$Q_{Lite}$  = component of internal load due to space heat gain from light fixtures; (W).

$(W)_{Lite}$  = the total number of watts from the light fixtures.

$(CLF)_{Lite}$  = cooling load factor of lighting obtained from Ref. [12].

$Q_{PT}$  = internal load due to heat gain from people; (Btu/(hr·person)) or (W/person).

$Q_{PS}$  = sensible people load; (Btu/(hr·person)) or (W/person).

$Q_{PL}$  = latent people load; (Btu/(hr\*person)) or (W/person).

$N_P$  = number of people occupying the space.

$(HG)_{PS}$  = sensible heat gain from occupants obtained from Ref. [13].

$(HG)_{PL}$  = latent heat gain from occupants obtained from Ref. [13].

$Q_{eqpT}$  = internal load due to heat gain from appliances; (Btu/hr) or (W).

$Q_{eqpS}$  = internal load due to sensible heat gain from appliances; (Btu/hr) or (W).

$(HG)_{eqp}$  = recommended rate of sensible heat gain obtained from Ref. [15]; (Btu/hr) or (W).

$(CLF)_{eqp}$  = cooling load factor for appliances obtained from Ref. [16].

$Q_{eqpL}$  = internal load due to latent heat gain from appliances obtained from Ref. [15]; (Btu/hr) or (W).

### 3.3.4 Ventilation and Infiltration Air Loads

The ventilation and infiltration air loads are calculated as follows [4]:

$$(Q_{vent})_{SC} = (V_{vent}) (1.1) (\Delta T) \quad (11)$$

$$(Q_{vent})_{LC} = (V_{vent}) (4840) (\Delta W) \quad (12)$$

$$(Q_{inf})_{SC} = (V_{inf}) (1.1) (\Delta T) \quad (13)$$

$$(Q_{inf})_{LC} = (V_{inf}) (4840) (\Delta W) \quad (14)$$

where:

$(Q_{vent})_{SC}$  = sensible heat gain due to ventilation;  
(Btu/hr).

$(Q_{vent})_{LC}$  = latent heat gain due to ventilation;  
(Btu/hr).

$(Q_{inf})_{SC}$  = sensible heat gain due to infiltration;  
(Btu/hr).

$(Q_{inf})_{LC}$  = latent heat gain due to infiltration;  
(Btu/hr).

$(V_{vent})$  = rate of ventilation air flow from the  
system operation data; (ft<sup>3</sup>/m).

$(V_{inf})$  = rate of infiltration air flow obtained from  
Ref. [17]; (ft<sup>3</sup>/m).

$(\Delta T)$  = difference between inside and outside air  
temperature; (F).

$(\Delta W)$  = difference between inside and outside  
moisture content in the air; (pound of  
water per pound of dry air).

1.1 = constant obtained from Ref. [17].

4840 = constant obtained from Ref. [17].

### 3.4 Summary of Heating Load Calculation Method [5]

The heating load calculations are performed in accordance with the procedures described in Ref. [5]; a summary of the heating load calculation method is shown in the following section.

#### 3.4.1 Transmission Load ( $Q_{TH}$ )

The transmission load ( $Q_{TH}$ ) consists of the heat losses through roof ( $Q_{RH}$ ), walls ( $Q_{WH}$ ), glass ( $Q_{GH}$ ) and floor ( $Q_{FH}$ ). The total transmission load is expressed as follows:

$$Q_H = U \cdot A \cdot \Delta T \quad (15)$$

where:

$Q_H$  = transmission heat loss due to roof, walls, glazing and floor (above or below grade);  
(Btu/hr) or (kW).

$U$  = thermal transmittance obtained from Ref.[8];  
(Btu/(hr · ft<sup>2</sup> · F)) or (W/(m<sup>2</sup> · K)).

$A$  = corresponding heat transfer surface area;  
(ft<sup>2</sup>) or (m<sup>2</sup>).

$\Delta T$  = difference between inside and outside  
temperature; (F) or (K).

For floors on grade, the heat loss is calculated by:

$$Q_{FH}(\text{on grade}) = (F_2) (P) (\Delta T) \quad (16)$$

where:

$F_2$  = the floor heat loss coefficient obtained  
from Ref. [18]; (Btu/(hr · F) per foot of  
perimeter)) or (W/K per m of perimeter).

$P$  = perimeter or exposed edge of floor; (ft) or  
(m).

$\Delta T$  = difference between inside and outside  
temperature; (F) or (K).

### 3.4.2 Ventilation ( $Q_{vent}$ ) and Infiltration ( $Q_{inf}$ ) Air

#### Loads

The heat loads caused by air ventilation and infiltration are calculated by the following formulae [5]:

$$(Q_{vent})_{SH} = (V_{vent}) (0.018) (\Delta T) \quad (17)$$

$$(Q_{vent})_{LH} = (V_{vent}) (79.5) (\Delta W) \quad (18)$$

$$(Q_{inf})_{SH} = (V_{inf}) (0.018) (\Delta T) \quad (19)$$

$$(Q_{inf})_{LH} = (V_{inf}) (79.5) (\Delta W) \quad (20)$$

where:

$(Q_{vent})_{SH}$  = sensible heat loss due to ventilation;  
(Btu/hr).

$(Q_{vent})_{LH}$  = latent heat loss due to ventilation;  
(Btu/hr).

$(Q_{inf})_{SH}$  = sensible heat loss due to infiltration;  
(Btu/hr).

$(Q_{inf})_{LH}$  = latent heat loss due to infiltration;  
(Btu/hr).

$(V_{vent})$  = rate of ventilation air flow; (ft<sup>3</sup>/m).

$(V_{inf})$  = rate of infiltration air flow; (ft<sup>3</sup>/m).

$(\Delta T)$  = difference between inside and outside  
temperature; (F).

$(\Delta W)$  = difference between inside and outside  
moisture content of air; (pound of water  
per pound of dry air).

### 3.5 Summary of the Results of the Calculated Loads From the Standard Method [4,5]

The summary of the cooling and heating loads  
calculated are shown in Tables 2 and 3 respectively.



Table 2

Summary of Cooling Load Components  
Calculated from the Standard Method [4]

<u>Component Description</u>		Load (Btu/hr)	
		Sensible ( $Q_{SC}$ )	Latent ( $Q_{LC}$ )
1.0	<u>Transmission</u> ( $Q_{TC}$ )	23,073	
1.1	Wall Transmission ( $Q_{WC}$ )	7,607	
1.2	Roof Transmission ( $Q_{RC}$ )	12,495	
1.3	Glass Transmission ( $Q_{GC}$ )	2,971	
2.0	<u>Solar</u> ( $Q_{Sol}$ )	195,716	
3.0	<u>Internal</u> ( $Q_{intC}$ )	96,581	39,740
3.1	Lights ( $Q_{Lite}$ )	60,048	
3.2	People ( $Q_{PT}$ )	34,170	34,170
3.3	Equipment ( $Q_{eqPT}$ )	2,363	5,570
4.0	<u>Outside Air</u>		
4.1	Infiltration ( $Q_{infC}$ )	7,088	11,956
4.2	Ventilation ( $Q_{ventC}$ )	23,760	40,076
5.0	<u>Miscellaneous</u>	-	-
Total		346,218	91,772
<p><u>Total Load</u> = <math>Q_{SC} + Q_{LC}</math>  = 437,990 Btu/hr  = 128.4 kW  = 36.5 tons</p> <p>Where 1 ton= 12,000 Btu/hr  1 kW = 3,412 Btu/hr</p>			

Table 3

Summary of Heating Load Components  
Calculated from the Standard Method [5]

<u>Load Description</u>	Load in Btu/hr	
	Sensible ( $Q_{SH}$ )	Latent ( $Q_{LH}$ )
1.0 <u>Transmission</u> ( $Q_{TH}$ )	289,534	
1.1 Wall Transmission ( $Q_{WH}$ )	77,326	
1.2 Roof Transmission ( $Q_{RH}$ )	37,714	
1.3 Glass Transmission ( $Q_{GH}$ )	174,494	
2.0 <u>Floors on Grade</u> ( $Q_F$ )	52,200	
3.0 <u>Outside Air</u>		
3.1 Infiltration ( $Q_{infH}$ )	51,037	13,515
3.2 Ventilation ( $Q_{ventH}$ )	122,861	15,682
Total Sub Loads	515,632	29,197
<p><u>Total Load</u> = <math>Q_{SH} + Q_{LH}</math>  = 544,829 Btu/hr  = 159.7 kW</p> <p>Where 1 kW = 3,412 Btu/hr</p>		

## Chapter 4

Description of the Carrier Opcost

Load Calculation

Program

## CHAPTER 4

### 4.1 Description of the Carrier Opcost Load Calculation Program

In the Carrier Opcost program [3], the load calculations are performed using a modified bin method [3]. The 'bins' are defined as 5°F (2.8°C) temperature intervals, between the lowest and highest outdoor temperatures recorded for a given location (See Appendix 2). The hourly history of these bins for a typical year at selected locations are incorporated into the program [3] (See Appendix 2). The major phases in the load calculation method used in the Carrier Opcost program are illustrated in Fig. 7.

Details of the calculations method used in the Carrier Opcost program are presented in the following sections.

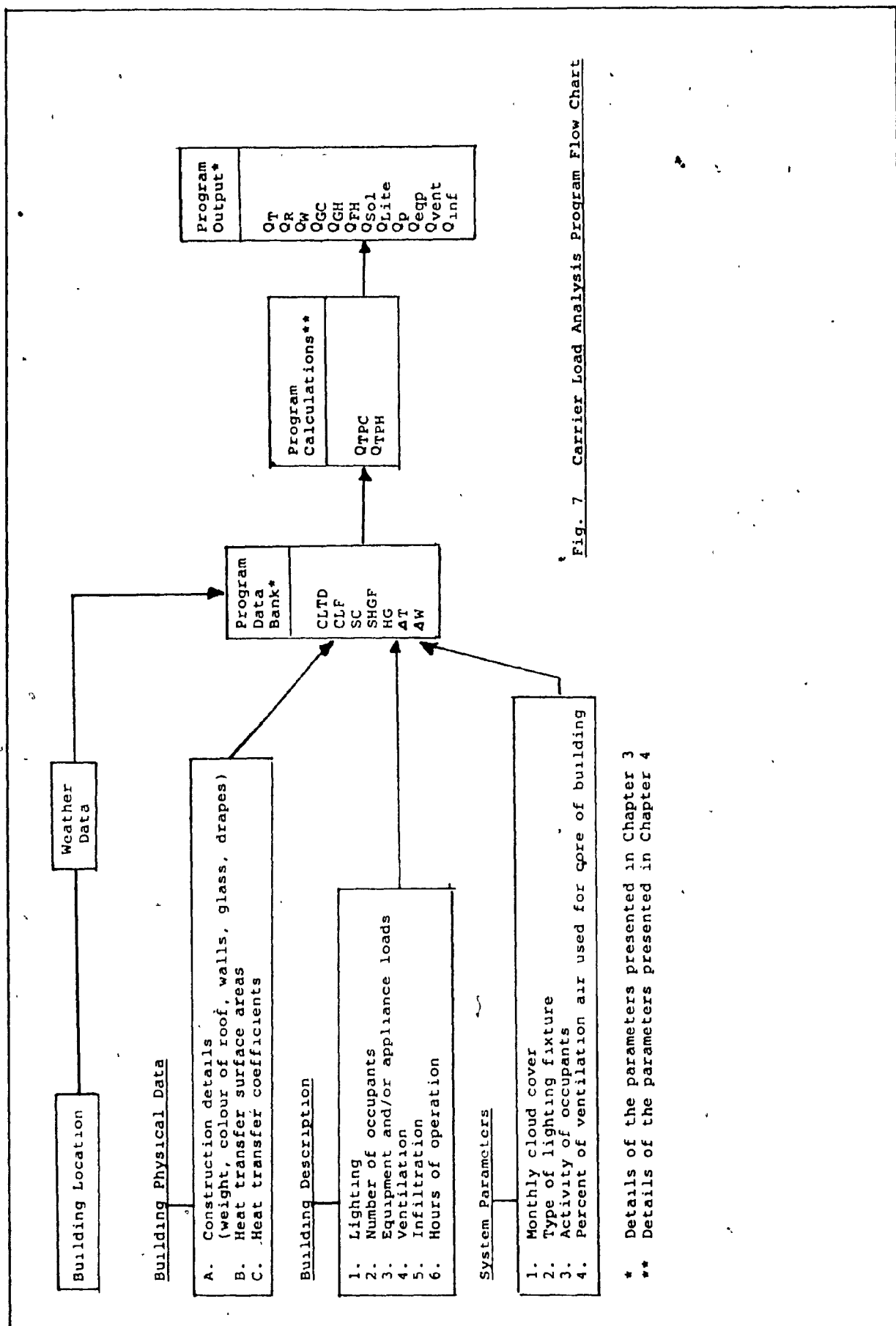


Fig. 7 Carrier Load Analysis Program Flow Chart

\* Details of the parameters presented in Chapter 3

\*\* Details of the parameters presented in Chapter 4

#### 4.2 Component Calculation Method

In this program, the cooling loads due to transmission ( $Q_{TC}$ ), solar ( $Q_{Sol}$ ), ventilation ( $Q_{ventC}$ ) and infiltration ( $Q_{infC}$ ) are assumed to be linear functions of outdoor temperatures [3]. Interior loads due to lights ( $Q_{Lite}$ ), people ( $Q_{PT}$ ), and equipment ( $Q_{eqPT}$ ) are calculated as averages over the following calculative periods:

- a) first calculative period represents the occupied hours;
- b) second calculative period represents unoccupied hours.

The duration of the calculative period is determined by the number of bin hours, which corresponds to the following schedule of operation:

"occupied" - heating and cooling systems operate normally;

"unoccupied" - the mode of operation is:

in summer - cooling is shut off;

in winter - heating is set back to  
predetermined minimum space  
temperature.

Load calculations are performed for the following  
selected outdoor temperature conditions:

A. Total Peak Cooling Load ( $Q_{TPC}$ )

The total peak cooling load is the mid point of the  
highest temperature bin occurring at any one location.

B. Total Peak Heating Load ( $Q_{TPH}$ )

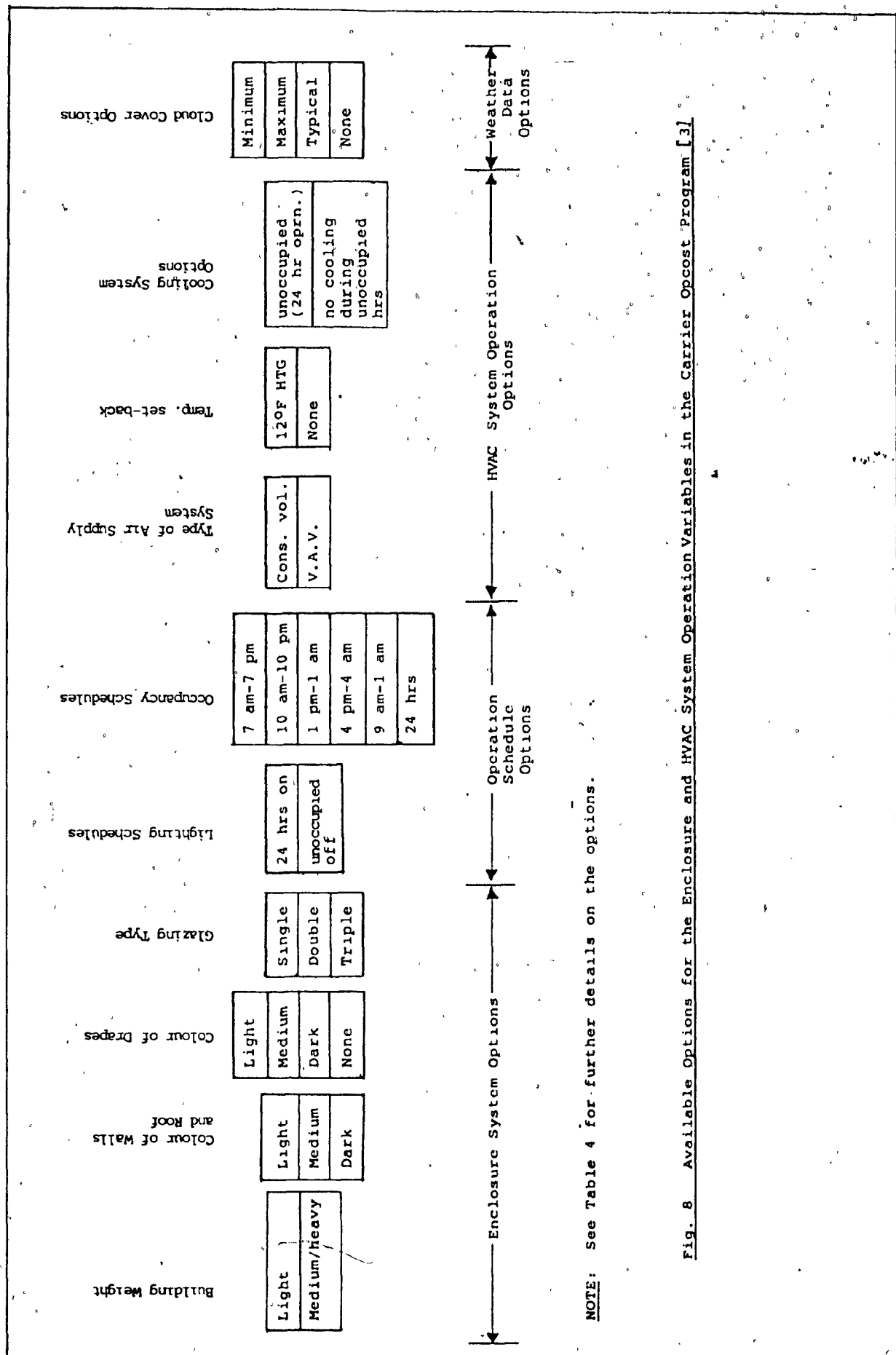
The total peak heating load is the mid point of the  
lowest temperature bin occurring at any one location.

#### 4.3 Description of the Available Input Options for Building Enclosure and HVAC System Operation Variables

In this section, the available input options in the "Opcost" program for the calculation of cooling and heating loads for the different enclosure and system operation variables, are presented. The details of the options available are shown in Fig. 8 and outlined in Table 4.

Typical percentage of available sunshine for Montreal, for various cloud cover conditions used in the program are shown in Table 5.





NOTE: See Table 4 for further details on the options.

Fig. 8 Available Options for the Enclosure and HVAC System Operation Variables in the Carrier Opcost Program [3]

Table 4

Details of the Available Options of the Carrier Opocast Program [3]

Type of Option	Components of the Option	Comments
1. Enclosure System Options	<p>A. Building weight - 1. light (10-40 lbm/ft<sup>2</sup>) 2. medium/heavy (&gt; 40 lbm/ft<sup>2</sup>)</p> <p>B. Colour of walls and roof(s) - 1. light 2. medium 3. dark</p> <p>C. Type of glass - Glazing Type <math>U_G</math> (Btu/hr-ft<sup>2</sup>-F) 1. single glazing 1.13 2. double glazing 0.55 3. triple glazing 0.36</p> <p>D. Interior shading - Colour of Drapes S.C. (shading coefficient) dark 0.75 medium 0.65 light 0.56 no drapes 1.00</p>	<p>Weight factor = <math>\frac{\text{weight of walls and partitions}}{\text{conditioned floor area}}</math></p> <p>This data is used to compute the CLTD or effective temperature difference.</p> <p>Fixed values in the program.</p> <p>Fixed values in the program.</p>
2. Weather Data Options	<p>Cloud Cover - minimum maximum typical none</p>	<p>1. Bin weather data for selected locations stored in the program.</p> <p>2. Percentage of the available sunshine for each month for each of the four options, for a given location stored in the program (See Table 8).</p>
3. Lighting and Occupancy Schedules	<p>A. Lighting - 1. on all the time 2. off during unoccupied hours</p> <p>B. Occupancy - (occupancy schedule) 7:00 a.m. - 7:00 p.m. 10:00 a.m. - 10:00 p.m. 1:00 p.m. - 1:00 a.m. 4:00 p.m. - 4:00 a.m. 9:00 a.m. - 1:00 a.m. 24 hours</p>	<p>2 options</p> <p>6 options</p>
4. HVAC System Operation Options	<p>A. Type of supply air system - 1. constant volume 2. variable volume</p> <p>B. Temperature setback for heating - 1. 12°F during unoccupied hours 2. none</p> <p>C. Cooling during unoccupied hours - 1. cooling on 2. cooling off</p>	<p>2 options</p> <p>2 options</p> <p>2 options</p>

Table 5

Percentage of Available Sunshine for  
Montreal, Canada [3] (cloud cover)

Cloud cover type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	43	51	59	67	68	75	68	86	81	86	47	41
Maximum	26	34	41	48	53	55	58	60	53	42	28	20
Typical	35	43	50	58	61	65	73	73	67	54	38	31
None	100	100	100	100	100	100	100	100	100	100	100	100

#### 4.4 Description of the Output Data

For the case study, typical output data from the program [3] is shown in Appendix 2. The output data is presented for the following three conditions:

1. bin load - calculated for each bin temperature (cooling and heating).
2. maximum cooling load - calculated at summer design temperature at a particular elevation.
3. typical heating and cooling load - calculated for each bin temperature other than summer design temperature. (applies for heating and cooling loads)

The bin loads are presented in two series. The first series is for the occupied periods and the second series is for the unoccupied periods. The maximum load calculated is used for the purpose of equipment selection. The capacity of the maximum cooling load is calculated for clear sky conditions [3]. Typical loads for cooling and heating are calculated by including the effects of cloud cover and thermal storage. Peak heating load is calculated at the lowest bin (outdoor)

temperature for the selected location.

#### 4.5 Analysis of the Data

An evaluation of the effects of the building enclosure and HVAC system operation variables on the peak cooling and heating loads is presented in Chapter 5.

Among the input options available, the effects of certain variations such as the glazing type (single, double, triple), lighting schedule and cooling system shut down during unoccupied hours, may be determined from simple manual calculations. Consequently, this analysis is restricted to the variations of the other parameters available in the program. The parameters selected for analysis are listed in Table 6.

A listing of the twelve computer runs and their properties used for this study is presented in Table 6.1.

Table 6

A Summary of the Variations of Parameters Used  
for the Load Analysis

Parameter No.	Parameter Description	Runs No.
A1	Effect of building weight (light and medium/heavy construction)	1 & 2
A2	Effects of wall and roof colour variations	1 & 3
A3	Effects due to cloud cover type	2 & 5 & 6
A4	Effects of HVAC system operation variations	4 & 7
A5	Effects of temperature setback during heating operations	7 & 8
A6	Effects caused by the type of air handling system used	11 & 12
A7	Effects caused by the variation of the building occupancy schedule	9 & 10

Table 6.1

Details of the Variations Considered  
in the Load Analysis

Type of Input	Characteristics	Run No.											
		1	2	3	4	5	6	7	8	9	10	11	12
Building Enclosure	Building weight - light medium/heavy	x	x	x	x	x	x	x	x	x	x	x	x
	Wall & roof colour - light medium dark	x	x	x	x	x	x	x	x	x	x	x	x
	Drapes - light medium dark none	x	x	x	x	x	x	x	x	x	x	x	x
	Glass - single double triple	x	x	x	x	x	x	x	x	x	x	x	x
Weather Data Options	Cloud cover - minimum maximum typical none	x	x	x	x	x	x	x	x	x	x	x	x
HVAC System Operation	Setback - 12°F none	x	x	x	x	x	x	x	x	x	x	x	x
	Unoccupied cooling - yes no	x	x	x	x	x	x	x	x	x	x	x	x
	Constant volume Variable volume	x	x	x	x	x	x	x	x	x	x	x	x
Occupancy & Lighting	Occupancy schedule - 7:00 a.m. - 7:00 p.m. 10:00 a.m.-10:00 p.m. 24 hours	x	x	x	x	x	x	x	x	x	x	x	x
	Lights - on 24 hours off in unoc.	x	x	x	x	x	x	x	x	x	x	x	x

## Chapter 5

### Analysis of the Results



## 5.1 Effects of the Enclosure and HVAC System Parameters

### Variations on Peak Cooling and Heating Loads

The effects of the variations of the enclosure and system parameters on the peak cooling and heating loads are presented in Fig. 9 and Fig. 10 respectively.

An analysis of the effects caused by each parameter variation and a comparison between the corresponding peak cooling and heating loads with the loads obtained from the standard method of calculation [4,5] follows in this chapter.

#### 5.1.1 The Effects of the Building Weight Variation on the Peak Cooling and Heating Loads (A1)

A summary of the effects produced by the variation of the weight of construction on the peak cooling and heating loads is presented in Table 7. The corresponding component breakdown details are shown in Table 7A of Appendix 1.

Fig. 9 Effects of the Enclosure and System Parameters  
Variations on the Peak Cooling Load

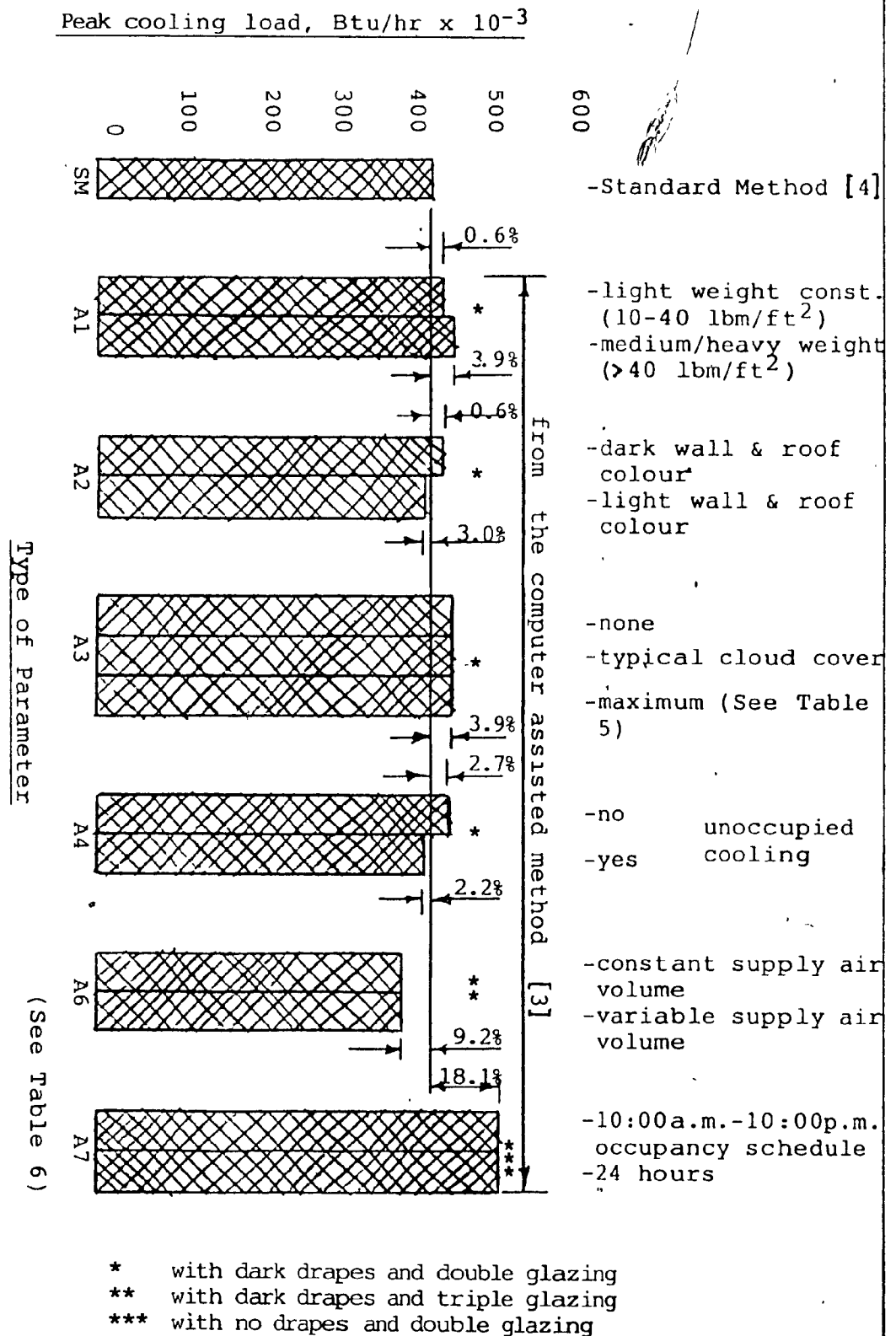




Table 7

A Summary of the Effects of Weight of Construction on  
Peak Cooling and Heating Loads

Run No.	Parameters Weight of Construction	Peak Cooling Load Btu/hr	Peak Heating Load Btu/hr
1	Light	440593	272587
2	Medium/Heavy	455115	290565
-	Standard Method	437990	544829

Medium/Heavy construction parameter produces a peak cooling load 3.2% greater and a peak heating load 6.6% greater than the corresponding peak loads of light weight construction.

The weight of construction appears not to have a significant effect on the peak cooling load when compared to the corresponding value calculated from the standard method. The computer calculated peak heating load is about 50% smaller than the corresponding load calculated from the standard method. This is caused by the heat gain components of solar radiation ( $Q_{Sol}$ ), and internal heat ( $Q_{int}$ ) which are subtracted from the total

heat loss of the building. In the standard method calculations, credits are not given for the heat gain components.

In practice, because these internal and solar heat gains may not be available at all times, various safety factors are used to determine the heating equipment's required capacity. These factors increase the calculated loads by 50% to 100% in order to ensure comfort conditions.

It is also of note that medium/heavy construction attributes a smaller "lighting" load component in its peak heating load calculations, than it does for light weight construction (See Table 7A).

#### 5.1.2 The Effects of Wall and Roof Colour Variations on Peak Cooling and Heating Loads (A2)

A summary of the effects produced by the variation of wall and roof colour on the peak cooling and heating loads is presented in Table 8. The corresponding component breakdown details are shown in Table 8A of Appendix 1.

Table 8

A Summary of the Effects of Wall and Roof Colour on  
Peak Cooling and Heating Loads

Run No.	Parameters Colour of Walls & Roof	Peak Cooling Load Btu/hr	Peak Heating Load Btu/hr
1	Dark	440593	290565
3	Light	424495	279114
-	Standard Method	437990	544829

The dark wall and roof colour component produces a peak cooling load 3.6% greater and a peak heating load 3.9% greater than the corresponding loads for light wall and roof colour.

The wall and roof colour parameter appears not to have a significant effect on the peak cooling load when compared to the corresponding value calculated from the standard method.

The computer calculated peak heating load is about 50% smaller than the corresponding load calculated from the standard method and for the same reasons as described in 5.1.1.

5.1.3 The Effects of Cloud Cover Type on Peak Cooling and Heating Loads (A3)

A summary of the effects produced by the variation of cloud cover type on the peak cooling and heating loads is presented in Table 9. The corresponding component breakdown details are shown in Tables 9A and 9B of Appendix 1.

Table 9

A Summary of the Effects of Cloud Cover on Peak Cooling and Heating Loads

Run No.	Parameter Cloud Cover	Peak Cooling Load Btu/hr	Peak Heating Load Btu/hr
2	None	455115	290565
5	Typical	455115	414535
6	Maximum	455115	431701
-	Standard Method	437920	544829

The Opcost program calculations for peak (maximum) cooling load assume clear sky (no cloud cover effect) [3]. As shown in Table 9 and Fig. 9, the three different cloud cover types presented in this study produced the same peak cooling load.

The peak heating load calculated with no cloud cover (100% sunshine) was the smallest peak heating load among the three options of this study and also produced a load about 50% smaller than the corresponding load calculated from the standard method. For the maximum cloud cover option (less sunshine than the previous case) the peak heating load was considerably larger and the difference to the standard method calculated value was reduced to about 20%. This is due to the effect of the solar radiation ( $Q_{sol}$ ) component as explained in 5.1.1.

#### 5.1.4 The Effects of HVAC System Operation Variations

(A4)

A summary of the effects produced on the peak cooling and heating loads, by variations in the HVAC System Operations is presented in Table 10. The



corresponding component breakdown details are shown in Table 10A of Appendix 1.

Table 10

A Summary of the Effects of HVAC System  
Operation Variations on Peak Cooling  
and Heating Loads

Run No.	Parameter Unoccupied Cooling	Peak Cooling Load Btu/hr	Peak Heating Load Btu/hr
4	no	450098	292854
7	yes	428336	394867
-	Standard Method	437990	544829

The peak cooling load is reduced by 4.8% when the system provides cooling during inoccupancy. This is caused by the removal of the accumulated heat during the unoccupied time period, by the cooling system. However, the energy consumption will be higher for such a case, compared to the condition when there is no unoccupied cooling.

This parameter appears to have no significant effect on the peak cooling load when compared to the corresponding value calculated from the standard method.

The peak heating load as calculated by the computer is almost 50% smaller when there is no unoccupied cooling but only about 27% smaller when unoccupied cooling is provided, in comparison with standard method calculations. This is due to the same reasons explained in 5.1.1. The relative large difference between the two computer assisted calculations results is due to a large difference in their solar radiation component ( $Q_{sol}$ ) (See Table 10A).

#### 5.1.5 The Effects of Temperature Setback During Heating Operations (A5)

A summary of the effects produced by space temperature setback during inoccupancy on the peak heating load is presented in Table 11. The corresponding component breakdown details are shown in Tables 11A and 11B of Appendix 1.

Table 11

A Summary of the Effects of Setback on the

Peak Cooling and Heating Loads

Run No.	Parameter Setback	Peak Occupied Cooling Load Btu/hr	Peak Occupied Heating Load Btu/hr	Peak Unoccupied Heating Load Btu/hr
7	12°F	428336	-394867	-372784
8	None	428336	-394867	-409067
-	Standard Method	437990	-544829	-

A setback of 12°F produces an 8.9% reduction in the peak heating load for periods of inoccupancy. This is proportional to the changed value of  $\Delta T$  used in the calculations.

The computer calculated peak heating load is about 25% smaller than the corresponding load calculated from the standard method. This difference is due to the same reasons explained in 5.1.1.

#### 5.1.6 The Effects of the Type of Air Handling System on the Cooling and Heating Loads (A6)

A summary of the effects produced by the variation in the air handling system type on the peak cooling and heating is presented in Table 12. The corresponding component breakdown details are shown in Table 12A of Appendix 1.

Table 12

A Summary of the Effects of Air Handling  
System Type Variations on the  
Peak Cooling and Heating Loads

Run No.	Parameter Air Handling System	Peak Cooling Load Btu/hr	Peak Heating Load Btu/hr
11	Constant Volume	397797	313352
12	Variable Air Volume	397797	341620
-	Standard Method	437990	544829

The type of air handling system used has no effect on the peak cooling load, and shows a 9.2% difference when compared to corresponding load as calculated from the standard method. Most of the difference is attributed to the triple glazing ( $U_G = 0.36$ ) used in the computer assisted method instead of the double glazing ( $U_G = 0.55$ ) used in standard method calculations. Thus, it can be seen that the type of air handling system has no significant effect on the peak cooling load.

A constant volume air handling system has a peak heating load 9% smaller than the corresponding load of a variable air volume system. The variable air volume system delivers less air, and thus uses less fan horse power than the constant volume system. This translates into a smaller "Fan and Duct" heat gain component, and thus a larger net total heat loss load for the variable air volume system. (See Table 12A)

The computer assisted peak heating load is about 40% smaller than the corresponding load calculated from the standard method. This can be explained by the difference in glazing type (as described above) and the reasons outlined in 5.1.1.

#### 5.1.7 The Effects Caused by the Variation of the Building Occupancy Schedule (A7)

A summary of the effects produced by the variation of the building occupancy schedule on the peak cooling and heating loads is presented in Table 13. The corresponding component breakdown details are shown in Table 13A of Appendix 1.

Table 13

A Summary of the Effects of Building  
Occupancy Schedule Variations on the  
Peak Cooling and Heating Loads

Run No.	Parameter Occupancy Schedule	Peak Cooling Load Btu/hr	Peak Heating Load Btu/hr
9	10:00 a.m. - 10:00 p.m.	517471	346311
10	24 Hours	517471	326483
-	Standard Method	437990	544829

The building occupancy schedule has no effect on the peak cooling load. The peak cooling load calculated by the computer assisted method is 18.1% greater than the corresponding load calculated from the standard method. This difference is attributed to a "No Drapes" shading coefficient of 1.00 in the computer method, compared to a 0.75 shading coefficient used in the standard method.

The 24 hour (continuous) occupancy has a 5.7% smaller peak heating load than the corresponding load of the 12 hour (10:00 a.m. - 10:00 p.m.) occupancy. The difference is due specifically to the "lighting" component. (See Table 13A)

The computer assisted method produces a peak heating load about 40% smaller than the corresponding load calculated from the standard method. This is explained by the difference in the shading factor (as described above) and the reasons outlined in 5.1.1.



## Chapter 6

### Conclusion

## Chapter 6

### Conclusions

The conclusions from this study may be summarized as follows:

1. In the Carrier Opcost program the peak cooling loads do not appear to be sensitive to the variations of the following parameters:

- A. Building Weight
- B. Wall and Roof Colour
- C. Cloud Cover
- D. Unoccupied Cooling
- E. Temperature Setback
- F. Air Handling System Type
- G. Occupancy Schedule

2. For variations of the individual elements considered (A1-A7), the corresponding variations in the peak cooling loads computed from the program are found to be negligible.

3. For the variations of the individual parameters considered (A1-A7), the results for the peak cooling load computed from the program are very similar (+4%) to those from the corresponding manual calculations.

4. Among the variations of the input parameters considered (A1-A7), the effects of the variations of items A1, A2, and A5 to A7 on the peak heating load computed from the program, are found to be negligible. However, the corresponding effects of the variations of cloud cover type (A3) and unoccupied cooling (A4) are considerable (20% to 30%).

5. The variation of the input parameters considered, produce significant differences (20% to 50%) in the calculated peak heating load obtained from the manual and the computer assisted method.

Consequently, careful attention should be given to the input choices for the computer assisted peak heating load calculations, in order to minimize potential errors.

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Appendix 1

Detailed Component Breakdown Results of  
Peak Cooling and Heating Loads

Table 7A

Peak Load Effects Due to Variation of Weight of Construction  
(Comparison of Runs 1 and 2) (Al)

Load Description	Maximum Cooling					Heating				
	Sensible		Latent		%	Sensible		Latent		%
	Run 1	Run 2	Run 1	Run 2		Run 1	Run 2	Run 1	Run 2	
1.0 Transmission (Qt)	81417	62194	-	-	23.6	-371916	-377503	-	-	-1.5
1.1 Wall	28346	9906	-	-	65.1	-61449	-67122	-	-	-9.2
1.2 Roof	16718	15935	-	-	4.7	-31762	-31676	-	-	-0.3
1.3 Glass	36353	36353	-	-	0	-278705	-278705	-	-	0
2.0 Solar (Qsol)	108634	140246	-	-	29.1	199268	199268	-	-	0
3.0 Internal (Qint)	142096	143907	-	-	-1.3	132152	119757	-	-	9.4
3.1 Lights	71031	71031	-	-	0	61087	46881	-	-	23.3
3.2 People	32904	32904	27532	27532	0	32904	32904	27532	27532	0
3.3 Fan and Duct Gain	38161	39972	-	-	-4.7	38161	39972	-	-	-4.7
4.0 Outside Air	32793	32793	-	-	0	-232086	-232086	-	-	0
4.1 Infiltration and Equipment	9254	9254	12576	-12651	0	-51620	-51620	1970	1970	0
4.2 Ventilation	23539	23539	35544	35794	0	-180466	-180466	0	0	0
5.0 Sub Total Loads	364941	379139	75652	75976	-3.9	-272582	-290564	0	0	0
5.1 Total Loads - Run 1	-440593					-272582				
5.1 Total Loads - Run 2	455115					-290565				

All Loads are in Btu/hr.  
See Table 6 for run identification.

$$\% = \left[ \frac{\text{Run 1} - \text{Run 2}}{\text{Run 1}} \right] \times 100$$



Table 8A

Peak Load Effects Due to Variations in Wall and Roof Colours  
(Comparison of Runs 1 and 3) (A2)

Load Description	Maximum Cooling						Heating					
	Sensible			Latent			Sensible			Latent		
	Run 1	Run 3	%	Run 1	Run 3	%	Run 1	Run 3	%	Run 1	Run 3	%
1.0 Transmission (Or)	81417	67056	17.6	-	-	-	-371916	-376994	-1.4	-	-	-
1.1 Wall	28346	19665	30.6	-	-	-	-61449	-65565	-6.7	-	-	-
1.2 Roof	16718	11038	34.0	-	-	-	-31762	-32724	-3.0	-	-	-
1.3 Glass	36356	36353	0	-	-	-	-278705	-278705	0	-	-	-
2.0 Solar (Qsol)	108634	108634	0	-	-	-	199268	199268	0	-	-	-
3.0 Internal (Qing)	142096	140643	1.0	-	-	-	132152	130699	1.1	-	-	-
3.1 Lights	71031	71031	0	-	-	-	61087	61087	0	-	-	-
3.2 People	32904	32904	0	27532	27532	0	32904	32904	0	27532	27532	0
3.3 Fan and Duct Gain	38154	36708	3.8	-	-	-	38161	36708	3.8	-	-	-
4.0 Outside Air	32793	32793	0	-	-	-	-232086	-232086	0	-	-	-
4.1 Infiltration and Equipment	9254	9254	0	12576	12511	0.5	-51620	-51620	0	1970	1970	0
4.2 Ventilation	23539	23539	0	35544	35327	0.6	-180466	-180466	0	0	0	0
5.0 Sub Total Loads	364941	349125	4.3	75652	75370	0.37	-290565	-279114	3.9	0	0	0
5.1 Total Loads - Run 1	440593						-290565					
Run 3	424495						-279114					

All Loads are in Btu/hr.  
See Table for run identification.

$$\% = \left[ \frac{\text{Run 1} - \text{Run 3}}{\text{Run 1}} \right] \times 100$$

Table 9A

**Peak Load Effects Due to Variation of Type of Cloud Cover**  
(Comparison of Runs 2 and 5) (A3)

Load Description	Maximum Cooling					Heating				
	Sensible		Latent			Sensible		Latent		
	Run 2	Run 5	Run 2	Run 5		Run 2	Run 5	Run 2	Run 5	
1.0 Transmission (Qt)	62194	62194	0	-		-337503	-381006	-0.9	-	
1.1 Wall	9906	9906	0	-		-67122	-70625	-5.2	-	
1.2 Roof	15935	15935	0	-		-31676	-31676	0	-	
1.3 Glass	36353	36353	0	-		-278705	-278705	0	-	
2.0 Solar (Qsol)	140246	140246	0	-		159268	78801	60.0	-	
3.0 Internal (Qint)	143907	143907	0	-		119757	119757	0	-	
3.1 Lights	71031	71031	0	-		46881	46881	0	-	
3.2 People	32904	32904	0	27532	27532	32904	32904	27532	27532	0
3.3 Fan and Duct Gain	39972	39972	0	-	-	39972	39972	0	-	
4.0 Outside Air	32793	32793	0	-	-	-232086	-232086	0	-	
4.1 Infiltration and Equipment	9254	9254	0	12651	12651	-51620	-51620	0	1970	0
4.2 Ventilation	23539	23539	0	36794	36794	-180466	-180466	0	0	0
5.0 Sub Total Load	379139	379139	0	75976	75976	-290565	-414535	42.7	0	0
5.1 Total Loads - Run 2		455115							-290565	
Run 5		455115							-414535	

$$\left[ \frac{\text{Run 2} - \text{Run 5}}{\text{Run 2}} \right] \times 100$$

All Loads are in Btu/hr.  
See Table 6 for run identification.

Table 9B

Peak Load Effects Due to Variation of Type of Cloud Cover  
(Comparison of Runs 2 and 6) (A3)

Load Description	Maximum Cooling						Heating					
	Sensible			Latent			Sensible			Latent		
	Run 2	Run 6	%	Run 2	Run 6	%	Run 2	Run 6	%	Run 2	Run 6	%
1.0 Transmission (Qt)	62194	62194	0	-	-	-	-377503	-381491	-1.0	-	-	-
1.1 Wall	9906	9906	0	-	-	-	-67122	-71110	-5.9	-	-	-
1.2 Roof	15935	15935	0	-	-	-	-31676	-31676	0	-	-	-
1.3 Glass	36353	36353	0	-	-	-	-278705	-278705	0	-	-	-
2.0 Solar (Qsol)	140246	140246	0	-	-	-	-199268	62120	68.8	-	-	-
3.0 Internal (Qint)	143907	143907	0	-	-	-	119757	119757	0	-	-	-
3.1 Lights	71031	71031	0	-	-	-	46881	46881	0	-	-	-
3.2 People	32904	32904	0	27532	27532	0	32904	32904	0	27532	27532	0
3.3 Fan and Duct Gain	39972	39972	0	-	-	-	39972	39972	0	-	-	-
4.0 Outside Air	32793	32793	0	-	-	-	-232086	-232086	0	-	-	-
4.1 Infiltration and Equipment	9254	9254	0	12651	12651	0	-51620	-51620	0	1970	1970	0
4.2 Ventilation	23539	23539	0	35794	35794	0	-180466	-180466	0	0	0	0
5.0 Sub Total Load	379139	379139	0	75976	75976	0	-290565	-431701	48.6	0	0	0
5.1 Total Loads - Run 2	455115						290565					
Run 6	455115						-431701					

All Loads are in Btu/hr.  
See Table 6 for run identification.

$$\left[ \frac{\text{Run 2} - \text{Run 6}}{\text{Run 2}} \right] \times 100$$

Table 10A

**Peak Load Effects Due to Variation of HVAC System Operation**  
(Comparison of Runs 4 and 7) (A4)

Load Description	Maximum Cooling						Heating					
	Sensible			Latent			Sensible			Latent		
	Run 4	Run 7	%	Run 4	Run 7	%	Run 4	Run 7	%	Run 4	Run 7	%
1.0 Transmission (Q <sub>T</sub> )	57621	57621	0	-	-	-	-379413	-379413	0	-	-	-
1.1 Wall	7978	7978	0	-	-	-	-68530	-68530	0	-	-	-
1.2 Roof	13290	13290	0	-	-	-	-32178	-32178	0	-	-	-
1.3 Glass	36353	36353	0	-	-	-	-278705	-278705	0	-	-	-
2.0 Solar (Q <sub>Sol</sub> )	140246	121584	13.3	-	-	-	199268	99869	49.8	-	-	-
3.0 Internal (Q <sub>int</sub> )	143527	140914	1.8	-	-	-	119377	116754	2.1	-	-	-
3.1 Lights	71031	71031	0	-	-	-	46881	46881	0	-	-	-
3.2 People	32904	32904	0	-27532	27532	0	32904	32904	0	27532	27532	0
3.3 Fan and Duct Gain	39592	36979	6.6	-	-	-	39592	36979	6.6	-	-	-
4.0 Outside Air	32793	32793	0	48379	47893	-	-232086	-232086	0	-	-	-
4.1 Infiltration and Equipment	9254	9254	0	12636	12524	-	-51620	-51620	0	1970	1970	0
4.2 Ventilation	23539	23539	0	35743	35369	-	-180466	-180466	0	0	0	0
5.0 Sub Total Load	368832	352912	4.3	75911	75424	-	-292854	-394867	34.8	0	0	0
5.1 Total Loads - Run 4	450098						-292854					
Run 7	428336						-394867					

All Loads are in Btu/hr.  
See Table 6 for run identification.

$$\% = \left[ \frac{\text{Run 4} - \text{Run 7}}{\text{Run 4}} \right] \times 100$$

Table 11A

The Effect of Temperature Setback (During Occupied Periods) on Peak Loads  
(Comparison of Runs 7 and 8) (A5)

Load Description	Maximum Cooling						Heating					
	Sensible			Latent			Sensible			Latent		
	Run 7	Run 8	%	Run 7	Run 8	%	Run 7	Run 8	%	Run 7	Run 8	%
1.0 Transmission (Q <sub>T</sub> )	57621	57621	0	-	-	-	-379413	-379413	0	-	-	-
1.1 Wall	7978	7978	0	-	-	-	-68530	-68530	0	-	-	-
1.2 Roof	13290	13290	0	-	-	-	-32178	-32178	0	-	-	-
1.3 Glass	36353	36353	0	-	-	-	-278705	-278705	0	-	-	-
2.0 Solar (Q <sub>Sol</sub> )	121584	121584	0	-	-	-	99869	99869	0	-	-	-
3.0 Internal (Q <sub>int</sub> )	140914	140914	0	-	-	-	116764	116764	0	-	-	-
3.1 Lights	71031	71031	0	-	-	-	46881	46881	0	-	-	-
3.2 People	32904	32904	0	27532	27532	0	32904	32904	0	27532	27532	0
3.3 Fan and Duct Gain	36979	36979	0	-	-	-	36979	36979	0	-	-	-
4.0 Outside Air	32793	32793	0	47893	47893	0	-232086	-232086	0	-	-	-
4.1 Infiltration and Equipment	9254	9254	0	12524	12524	0	-51620	-51620	0	1970	1970	0
4.2 Ventilation	23539	23539	0	35369	35369	0	-180466	-180466	0	0	0	0
5.0 Sub Total Load	352912	352912	0	75424	75424	0	-394867	-394867	0	0	0	0
5.1 Total Load - Run 7	428336						-394867					
Run 8	428336						-394867					

All Loads are in Btu/hr.  
See Table 6 for run identification.

$$\% = \left[ \frac{\text{Run 7} - \text{Run 8}}{\text{Run 7}} \right] \times 100$$

Table 11B

The Effects of Temperature Setback (During Inoccupancy) on Peak Loads  
(Comparison of Runs 7 and 8) (A5)

Load Description	Heating			
	Sensible		Latent	
	Run 7	Run 8	Run 7	Run 8
1.0 Transmission (Q <sub>T</sub> )	-325958	-377998	16.0	-
1.1 Wall	-56204	-66749	18.8	-
1.2 Roof	-27402	-32544	18.8	-
1.3 Glass	-242352	-278705	15.0	-
2.0 Solar (Q <sub>Sol</sub> )	0	0	0	-
3.0 Internal (Q <sub>Int</sub> )	0	0	0	-
3.1 Lights	0	0	0	-
3.2 People	0	0	0	0
3.3 Fan and Duct Gain	0	0	0	-
4.0 Outside Air	-46826	-53850	15.0	0
4.1 Infiltration and Equipment	-46826	-53850	15.0	0
4.2 Ventilation	0	0	0	0
5.0 Sub Total Load	-372784	-409067	-8.3	0
5.1 Total Load - Run 7 Run 8			-372784 -409067	0

All Loads are in Btu/hr.  
See Table 6 for run identification.

$$\left[ \frac{\text{Run 7} - \text{Run 8}}{\text{Run 7}} \right] \times 100$$

Table 12A

The Effects of Type of Air Handling System on Peak Cooling and Heating Loads  
(Comparison of Runs 11 and 12) (A6)

Load Description	Maximum Cooling				Heating			
	Sensible		Latent		Sensible		Latent	
	Run 11	Run 12	Run 11	Run 12	Run 11	Run 12	Run 11	Run 12
1.0 Transmission (Q <sub>T</sub> )	45063	45063	0	-	-283133	-283133	0	-
1.1 Wall	7978	7978	0	-	-68530	-68530	0	-
1.2 Roof	13290	13290	0	-	-32178	-32178	0	-
1.3 Glass	23795	23795	0	-	-182425	-182425	0	-
2.0 Solar (Q <sub>sol</sub> )	108055	108055	0	-	88757	88757	0	-
3.0 Internal (Q <sub>int</sub> )	137262	137262	0	-	113112	84844	25.0	-
3.1 Lights	71031	71031	0	-	46881	46881	0	-
3.2 People	32904	32904	0	27532	32904	32904	0	27532
3.3 Duct and Fan Gain	33327	33327	0	-	33327	5059	84.8	-
4.0 Outside Air	32793	32793	0	-	-232086	-232086	0	-
4.1 Infiltration and Misc.	9254	9254	0	12340	-51620	-51620	0	1970
4.2 Ventilation	23539	23539	0	34753	-180466	-180466	0	0
5.0 Sub Total Load	323173	323173	0	74624	-311352	-341620	-9.0	0
5.1 Total Load - Run 11	397797				-311352			
Run 12	397797				-341620			

All Loads are in Btu/hr.  
See Table 6 for run identification.

$$\% = \left[ \frac{\text{Run 11} - \text{Run 12}}{\text{Run 11}} \right] \times 100$$

Table 13A

The Effects of Building Occupancy Schedule on the  
Peak Cooling and Heating Loads  
 (Comparison of Runs 9 and 10) (A7)

Load Description	Maximum Cooling					Heating				
	Sensible		Latent		%	Sensible		Latent		%
	Run 9	Run 10	Run 9	Run 10		Run 9	Run 10	Run 9	Run 10	
1.0 Transmission (Q <sub>T</sub> )	57621	57621	-	-		-374889	-379211	-	-	-1.1
1.1 Wall	7978	7978	-	-		-65883	-67246	-	-	-2.1
1.2 Roof	13290	13290	-	-		-30301	-33260	-	-	-3.8
1.3 Glass	36353	36353	-	-		-278705	-278705	-	-	0.0
2.0 Solar (Q <sub>sol</sub> )	198305	198305	-	-		133159	133159	-	-	0
3.0 Internal (Q <sub>int</sub> )	151655	151655	-	-		127505	151655	-	-	-18.9
3.1 Lights	71031	71031	-	-		46881	71031	-	-	-31.5
3.2 People	32904	32904	27532	27532	0	32904	32904	27532	27532	0
3.3 Fan and Duct Gain	47720	47720	-	-		47720	47720	-	-	0
4.0 Outside Air	32793	32793	-	-		-232086	-232086	-	-	0
4.1 Infiltration and Misc.	9254	9254	12908	12908	0	-51620	-51620	1970	1970	0
4.2 Ventilation	23539	23539	36657	36657	0	-180466	-180466	0	0	0
5.0 Subtotal Load	440375	440375	77096	77096	0	-346311	-326483	0	0	5.7
5.1 Total Load - Run 9	517471					-346311				
Run 10	517471					-326483				

All Loads are in Btu/hr.  
 See Table 6 for run identification.

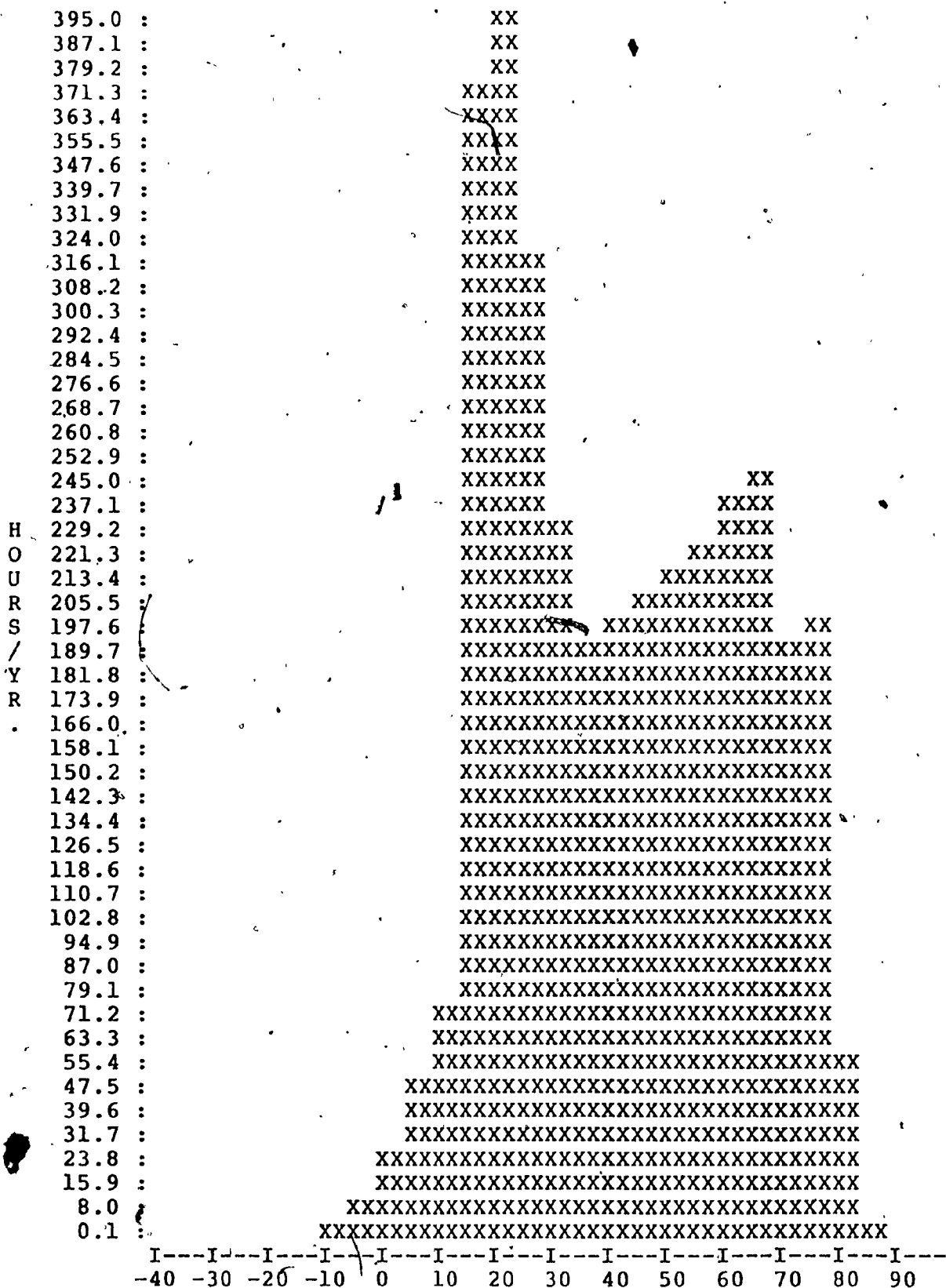
$$\% = \left[ \frac{\text{Run 9} - \text{Run 10}}{\text{Run 9}} \right] \times 100$$



Appendix 2

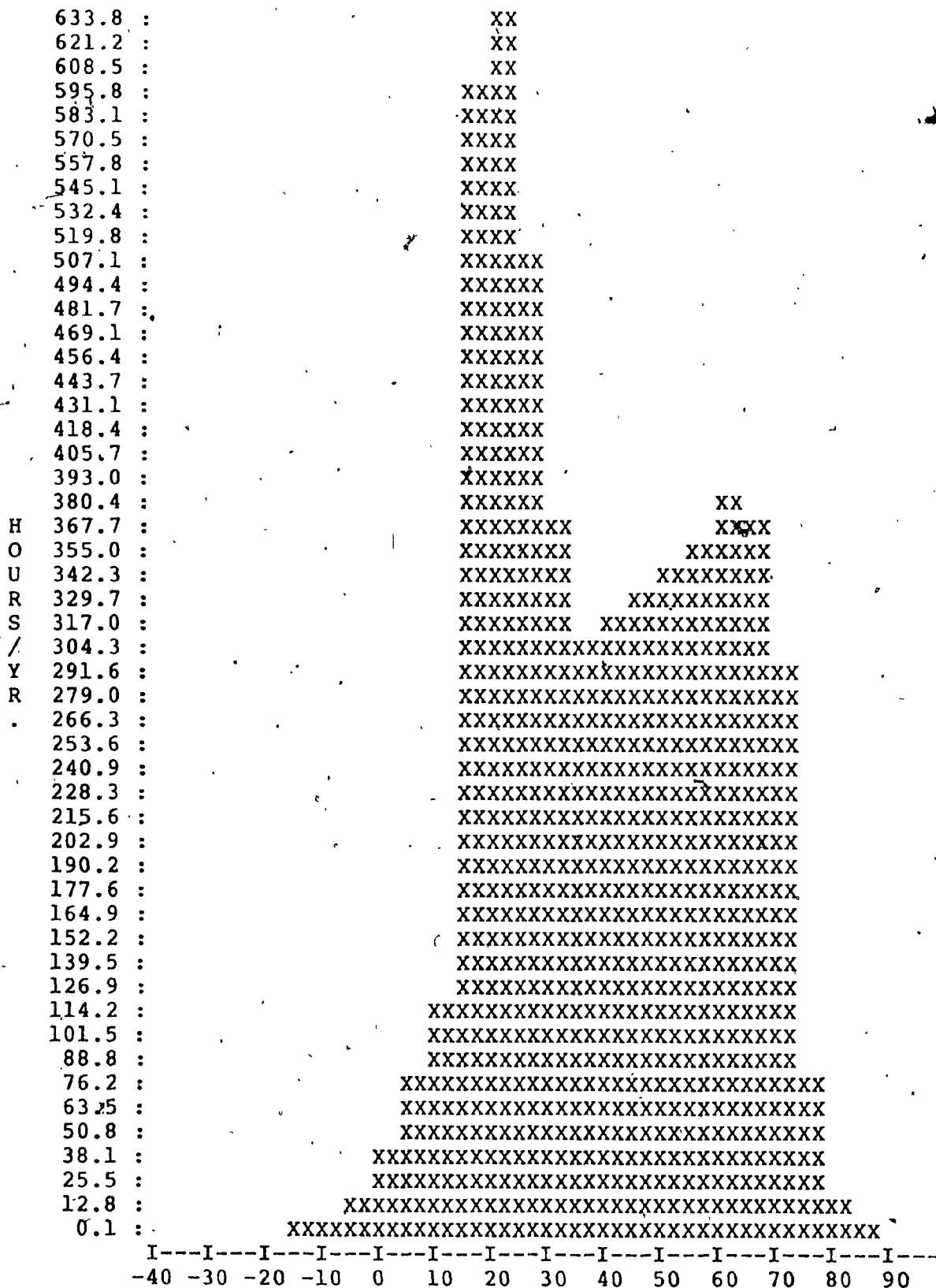
Carrier Opcost Program Data

# GRAPH OF OCCUPIED HOURS/YEAR/BIN-TEMP



BIN TEMPERATURES (DEG. F.) FOR MONTREAL

# GRAPH OF UNOCCUPIED HOURS/YEAR/BIN-TEMP



BIN TEMPERATURES (DEG. F.) FOR MONTREAL

TABLE 4

## CARRIER OPCOST INPUT DATA (Ref. 3)

1.	ENTER STATE	Canada
2.	ENTER CITY	Montreal
3.	ENTER DESIRED SUMMER INDOOR DRYBULB TEMPERATURE (50-90)	76
4.	ENTER DESIRED SUMMER INDOOR PERCENT RELATIVE HUMIDITY (0-100)	50%
5.	ENTER WEIGHT OF CONSTRUCTION 1=LIGHT, 2=MEDIUM-HEAVY (1 or 2)	2
6.	IS GLASS INTERNALLY SHADED (Y or N)	N
7.	ENTER COLOR OF THE WALLS 1=DARK, 2=MEDIUM, 3=LIGHT (1,2 or 3)	2
8.	ENTER COLOR OF ROOF 1= DARK, 2=MEDIUM, 3=LIGHT (1,2 or 3)	2
9.	ENTER OCCUPIED SCHEDULE 1=7 A.M. TO 6 P.M., 2=10 A.M. TO 9 P.M., 3=1 P.M. TO 12 MIDNIGHT, 4=4 P.M. TO 3 A.M., 5=24 HRS (1-5)	1
10.	ENTER DAYS PER WEEK OCCUPIED (1 to 7)	5.6 (Sat. 7 a.m. - 2 p.m.)
11.	ENTER CLOUD COVER 1=NONE, 2=MIN., 3=TYPICAL, 4=MAX (1-4)	3
12.	DO YOU COOL DURING THE UNOCCUPIED HOURS (Y or N)	N
LOAD INPUT		
13.	ENTER THE NAME OF THE JOB OR ZONE	Carrier Opcost Load Calculation
14.	ENTER DATE (MM/DD/YY)	
15.	ENTER THE INDOOR WINTER DESIGN TEMPERATURE (55-80)	72
16.	DO YOU USE NIGHT SETBACK (Y or N)	Y
16a.	HOW MANY DEGREES DO YOU SETBACK (1-30)	12
17.	ENTER THE TOTAL SQ.-FT OF THE BUILDING	13,430
18.	ENTER THE TOTAL SQ.-FT OF THE INTERIOR ZONE	6,446
19.	ENTER LIGHTING WATTS/SQ.-FT PERIMETER (1-6)	1.23
20.	ENTER LIGHTING WATTS/SQ.-FT INTERIOR (1-6)	1.23
21.	ARE THE LIGHTS ON DURING UNOCCUPIED PERIODS (Y or N)	N
22.	ENTER THE TYPE OF LIGHTS-PERIMETER 1=FLORESCENT, 2=INCANDESCENT OR "COOL" FLORESCENT (1 or 2)	1
23.	ENTER THE TYPE OF LIGHT-INTERIOR 1=FLORESCENT, 2=INCANDESCENT OR "COOL" FLORESCENT (1 or 2)	1
24.	LIGHTS ARE: 1=EXPOSED, 2=RECESSED (1 or 2)	2

(Continued)

TABLE 4

CARRIER OPCOST INPUT DATA (Ref. 3)

25.	ARE THERE ANY MISC. ELECTRICAL LOADS (Y or N)	N
25a.	OTHER ELECTRICAL OCCUPIED PERIMETER (WATTS/SQ.-FT) (0-5)	-
25b.	OTHER ELECTRICAL INTERIOR, OCCUPIED (WATTS/SQ.-FT) (0-5)	-
25c.	OTHER ELECTRICAL PERIMETER, UNOCCUPIED (WATTS/SQ.-FT) (0-5)	-
25d.	OTHER ELECTRICAL INTERIOR, UNOCCUPIED (WATTS/SQ.-FT) (0-5)	-
26.	WHAT IS THE LEAVING AIR TEMPERATURE OF THE TERMINALS (39-70)	55
27.	ENTER THE ESTIMATED TOTAL STATIC PRESSURE ON THE EVAP/FAN (1-9)	9"
28.	ENTER THE COLOR OF THE DRAPES: 1=LIGHT, 2=MEDIUM, 3=DARK, 4=NO DRAPES (1-4)Ø	-
29.	ENTER THE TRANSMISSION FACTOR FOR THE NORTHWALL	-
30.	ENTER THE TRANSMISSION FACTOR FOR THE SOUTHWALL	-
31.	ENTER THE TRANSMISSION FACTOR FOR THE WESTWALL	-
33.	ENTER THE TRANSMISSION FACTOR FOR THE NORTHEAST WALL	0.15
34.	ENTER THE TRANSMISSION FACTOR FOR THE NORTHWEST WALL	0.15
35.	ENTER THE TRANSMISSION FACTOR FOR THE SOUTHEAST WALL	0.15
36.	ENTER THE TRANSMISSION FACTOR FOR THE SOUTHWEST WALL	0.15
37.	ENTER THE TOTAL AREA OF THE ROOF	4,870
38.	ENTER THE TRANSMISSION FACTOR FOR THE ROOF	0.088
39.	ENTER THE TYPE OF GLASS: S=SINGLE, D=DOUBLE, T=TRIPLE (S,D or T)	D
40.	ENTER VENTILATION CFM PER SQ.-FT (.05 to 2)	0.134
41.	WHAT % OF VENTILATION AIR IS USED FOR THE CORE (0 to 100)	48
42.	ARE OUTDOOR AIR DAMPERS CLOSED DURING UNOCCUPIED PERIOD (Y or N)	Y
43.	IS THERE ANY INFILTRATION CFM (Y or N)	Y
43a.	INFILTRATION CFM PER SQ.-FT OCCUPIED (0 to 2)	537
43b.	INFILTRATION CFM PER SQ.-FT UNOCCUPIED (0 to 2)	537
44.	ENTER THE SQ.-FT PER PERSON (25-200)	100
45.	ENTER THE DEGREE OF ACTIVITY OF THE PEOPLE	2
	1=SEATED AT REST (THEATRE, ETC.), 2=OFFICE WORKER OR RETAIL STORE,	
	3=SEDENTARY WORK (RESTAURANT); 4=FACTORY, LIGHT WORK, 5= HEAVY WORK	
46.	ENTER THE NET AREA OF THE NORTHWALLS	-

(Continued)

TABLE 4

CARRIER OPCOST INPUT DATA (Ref. 3)

47.	ENTER THE NET AREA OF THE SOUTHWALLS	-	
48.	ENTER THE NET AREA OF THE EASTWALLS	-	
49.	ENTER THE NET AREA OF THE WESTWALLS	-	
50.	ENTER THE NET AREA OF THE NORTHEAST WALLS (SQ.-FT)	328	
51.	ENTER THE NET AREA OF THE NORTHWEST WALLS (SQ.-FT)	1601	
52.	ENTER THE NET AREA OF THE SOUTHEAST WALLS (SQ.-FT)	521	
53.	ENTER THE NET AREA OF THE SOUTHWEST WALLS (SQ.-FT)	3408	
54.	IS THE CEILING PLENUM USED AS A RETURN AIR PLENUM (Y or N)	Y	
55.	ENTER AREA OF NORTH WINDOWS (SQ.-FT)	-	
56.	ENTER AREA OF SOUTH WINDOWS (SQ.-FT)	-	
57.	ENTER AREA OF EAST WINDOWS (SQ.-FT)	-	
58.	ENTER AREA OF WEST WINDOWS (SQ.-FT)	-	
59.	ENTER AREA OF NORTHEAST WINDOWS (SQ.-FT)	2948	
60.	ENTER AREA OF NORTHWEST WINDOWS (SQ.-FT)	384	
61.	ENTER AREA OF SOUTHEAST WINDOWS (SQ.-FT)	2104	
62.	ENTER AREA OF SOUTHWEST WINDOWS (SQ.-FT)	72	
63.	ENTER THE TOTAL AREA OF SKYLIGHTS	NIL	
64.	ARE THE SKYLIGHTS DOUBLE-PANE (Y or N)	N	
65.	WHAT IS THE SOLAR TRANSMISSION FACTOR FOR THE SKYLIGHTS	-	
66.	ENTER ANY MISC. SENSIBLE LOADS (BTU's)	3150	
67.	ENTER ANY MISC. LATENT LOADS (BTU's)	5570	
68.	DO MISC. LOADS CONTINUE IN UNOCCUPIED PERIODS (Y or N)	N	
69.	ENTER THE TYPE OF SYSTEM 1=VAV, 2=CONSTANT VOLUME (1 or 2)	2	

# 3 AVAIL. SUNSHINE FOR MONTREAL

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
100 100 100 100 100 100 100 100 100 100 100 100

## LOAD CALCULATION

04/10/84

MONTREAL QUEBEC  
CONST=MED-HVY ID= 76/50 : 72 LAT = 45 ALT = 98  
WALL COLOR: DARK SETBACK = 12 IS = Y  
SYSTEM = CONSTANT VOLUME ROOF COLOR: DARK  
OCC. SCHED. : 7A-7P

SER# 31120821.6

1.	EST. MAXIMUM TONS @ 88F. =	37.93 (OCC.)
2.	EST. TYPICAL TONS @ 85F. =	41.79 (OCC.)
3.	EST. TYPICAL TONS @ 80F. =	38.25 (OCC.)
4.	EST. TYPICAL TONS @ 75F. =	31.93 (OCC.)
5.	EST. TYPICAL TONS @ 70F. =	29.17 (OCC.)
6.	EST. TYPICAL TONS @ 65F. =	23.47 (OCC.)
7.	EST. TYPICAL TONS @ 60F. =	20.68 (OCC.)
8.	EST. TYPICAL TONS @ 55F. =	17.17 (OCC.)
9.	EST. TYPICAL TONS @ 50F. =	10.52 (OCC.)
10.	EST. TYPICAL TONS @ 45F. =	7.91 (OCC.)
11.	EST. TYPICAL TONS @ 40F. =	5.99 (OCC.)
12.	EST. TYPICAL TONS @ 35F. =	4.06 (OCC.)
13.	EST. TYPICAL TONS @ 30F. =	0.00 (OCC.)
14.	EST. TYPICAL TONS @ 25F. =	-1.82 (OCC.)
15.	EST. TYPICAL TONS @ 20F. =	-3.78 (OCC.)
16.	EST. TYPICAL TONS @ 15F. =	-5.74 (OCC.)
17.	EST. TYPICAL TONS @ 10F. =	-7.70 (OCC.)
18.	EST. TYPICAL TONS @ 5F. =	-14.21 (OCC.)
19.	EST. TYPICAL TONS @ 0F. =	-16.21 (OCC.)
20.	EST. TYPICAL TONS @ -5F. =	-18.21 (OCC.)
21.	EST. TYPICAL TONS @ -10F. =	-20.21 (OCC.)
22.	EST. TYPICAL TONS @ -15F. =	-22.21 (OCC.)
23.	EST. TYPICAL TONS @ -20F. =	-24.21 (OCC.)

1.	EST. MAXIMUM TONS @ 88F. =	6.71 (UNOCC.)
2.	EST. TYPICAL TONS @ 85F. =	5.14 (UNOCC.)
3.	EST. TYPICAL TONS @ 80F. =	3.45 (UNOCC.)
4.	EST. TYPICAL TONS @ 75F. =	1.78 (UNOCC.)
5.	EST. TYPICAL TONS @ 70F. =	0.00 (UNOCC.)
6.	EST. TYPICAL TONS @ 65F. =	0.00 (UNOCC.)
7.	EST. TYPICAL TONS @ 60F. =	0.00 (UNOCC.)
8.	EST. TYPICAL TONS @ 55F. =	-0.95 (UNOCC.)
9.	EST. TYPICAL TONS @ 50F. =	-2.46 (UNOCC.)
10.	EST. TYPICAL TONS @ 45F. =	-3.97 (UNOCC.)
11.	EST. TYPICAL TONS @ 40F. =	-7.37 (UNOCC.)
12.	EST. TYPICAL TONS @ 35F. =	-8.87 (UNOCC.)
13.	EST. TYPICAL TONS @ 30F. =	-10.38 (UNOCC.)
14.	EST. TYPICAL TONS @ 25F. =	-14.36 (UNOCC.)
15.	EST. TYPICAL TONS @ 20F. =	-15.87 (UNOCC.)
16.	EST. TYPICAL TONS @ 15F. =	-17.37 (UNOCC.)
17.	EST. TYPICAL TONS @ 10F. =	-18.88 (UNOCC.)
18.	EST. TYPICAL TONS @ 5F. =	-20.39 (UNOCC.)
19.	EST. TYPICAL TONS @ 0F. =	-24.84 (UNOCC.)
20.	EST. TYPICAL TONS @ -5F. =	-26.35 (UNOCC.)
21.	EST. TYPICAL TONS @ -10F. =	-27.85 (UNOCC.)
22.	EST. TYPICAL TONS @ -15F. =	-29.36 (UNOCC.)
23.	EST. TYPICAL TONS @ -20F. =	-30.87 (UNOCC.)

		INPUTS				
ORIENTATION OF BUILDING WALL		N	S	E	W	RF
TRANSMISSION FACTORS		0.15	0.15	0.15	0.15	0.09
ORIENTATION OF BUILDING WALL		NE	NW	SE	SW	RF
TRANSMISSION FACTORS		0.15	0.15	0.15	0.15	0.09
SKYLIGHT U / SHADE FACTORS		0.76 / 0.65				
WINDOW U / SHADE FACTORS		0.55 / 0.75				
LIGHTS WITH BALLAST : EVERYWHERE						
		OUTPUTS				
NUMBER OF PEOPLE	= 134	SENSIBLE PEOPLE LOAD		=	32,904	
TOTAL LIGHTS	= 16,519	LIGHTING LOAD		=	71,031	
OTHER ELECTRICAL	= 0	OTHER ELECTRICAL		=	0	
AREA OF N. GLASS	= 0	NORTH GLASS SOLAR		=	0	
AREA OF S. GLASS	= 0	SOUTH GLASS SOLAR		=	0	
AREA OF E. GLASS	= 0	EAST GLASS SOLAR		=	0	
AREA OF W. GLASS	= 0	WEST GLASS SOLAR		=	0	
AREA OF NE GLASS	= 2,948	NE GLASS SOLAR		=	49,340	
AREA OF SE GLASS	= 2,104	SE GLASS SOLAR		=	62,947	
AREA OF SW GLASS	= 72	SW GLASS SOLAR		=	6,031	
AREA OF NW GLASS	= 384	NW GLASS SOLAR		=	21,927	
TOTAL GLASS AREA	= 5,508	TOTAL GLASS SOLAR		=	140,246	
TOTAL GLASS AREA	= 5,508	TOTAL GLASS TRANS.		=	36,353	
SKYLIGHT AREA	= 0	TOTAL SKYLIGHT SOLAR		=	0	
SKYLIGHT AREA	= 0	TOTAL SKYLIGHT TRANS.		=	0	
AREA OF N. WALL	= 0	N. WALL LOAD		=	0	
AREA OF S. WALL	= 0	S. WALL LOAD		=	0	
AREA OF E. WALL	= 0	E. WALL LOAD		=	0	
AREA OF W. WALL	= 0	W. WALL LOAD		=	0	
AREA OF NE WALL	= 328	NE WALL LOAD		=	393	
AREA OF NW WALL	= 1,601	NW WALL LOAD		=	1,039	
AREA OF SE WALL	= 521	SE WALL LOAD		=	1,430	
AREA OF SW WALL	= 3,408	SW WALL LOAD		=	7,044	
TOTAL WALL AREA	= 5,858	TOTAL WALL TRANS.		=	9,906	
AREA OF ROOF	= 4,870	ROOF LOAD		=	15,935	
AREA ADJ. N.D.T.	= 0	LOAD FROM N.D.T. AREA		=	0	
EVAP FAN H.P.	= 12.21	T. FAN & DUCT GAIN		=	39,972	
MISC + INFL SENS	= 9,254	MISC. + INFL SENS.		=	9,254	
VENTILATION CFM	= 1,800	O. A. SENSIBLE LOAD		=	23,539	
MISC+INFL LATENT	= 12,651	MISC. + INFL LATENT		=	12,651	
NUMBER OF PEOPLE	= 134	PEOPLE LATENT LOAD		=	27,532	
VENTILATION CFM	= 1,800	O.A. LATENT LOAD		=	35,794	
TOTAL CFM	= 14,220	TOTAL LATENT LOAD		=	75,976	
EFF ROOM SENSIBLE	= 325,490	EFF. ROOM LAT. LOAD		=	43,762	
--> GRAND TOTAL LOAD = 455,115 BTU'S <--						
A. EST. MAXIMUM TONS @ 88F. = 37.93 (OCC.)						
TOT SENSIBLE LOAD	= 379,139	TOT LATENT LOAD		=	75,976	
AREA (SQ FT)	= 13,430	SQ. FT PER TON		=	354	
SUPPLY AIR CFM	= 14,220	CFM PER SQ FT		=	1.06	
INDICATED ACT. RM. RH = 51.30%						
SPACE DRY BULB DEG.F. = 76						
DEGREES ROTATED = 0						
CEILING RETURN !!!						
ESHF = 0.88						
T. ST. EVAP FAN = 3.00						
BYPASS F. ASSUMED IS .1						
NET BLDG. ENVELOPE 'U' FACTOR = 0.27						
MAX. PERIM. LOAD AMBIGUITY = 0.0 TONS.						
CASE CREDITS = 0 / 0 MBH SENS./LAT.						
SUB-CASE RETURN AIR PERCENT = 0						
INTERIOR ZONE SQ. FT. = 6446						



		INPUTS				
ORIENTATION OF BUILDING WALL		N	S	E	W	RF
TRANSMISSION FACTORS		0.15	0.15	0.15	0.15	0.09
ORIENTATION OF BUILDING WALL		NE	NW	SE	SW	RF
TRANSMISSION FACTORS		0.15	0.15	0.15	0.15	0.09
SKYLIGHT U / SHADE FACTORS		0.76/	0.65			
WINDOW U / SHADE FACTORS		0.55/	0.75			
LIGHTS WITH BALLAST : EVERYWHERE						
		OUTPUTS				
NUMBER OF PEOPLE =	134	SENSIBLE PEOPLE LOAD =		32,904		
TOTAL LIGHTS =	16,519	LIGHTING LOAD =		46,881		
OTHER ELECTRICAL =	0	OTHER ELECTRICAL =		0		
AREA OF N. GLASS =	0	NORTH GLASS SOLAR =		0		
AREA OF S. GLASS =	0	SOUTH GLASS SOLAR =		0		
AREA OF E. GLASS =	0	EAST GLASS SOLAR =		0		
AREA OF W. GLASS =	0	WEST GLASS SOLAR =		0		
AREA OF NE GLASS =	2,948	NE GLASS SOLAR =		14,595		
AREA OF SE GLASS =	2,104	SE GLASS SOLAR =		176,725		
AREA OF SW GLASS =	72	SW GLASS SOLAR =		6,048		
AREA OF NW GLASS =	384	NW GLASS SOLAR =		1,901		
TOTAL GLASS AREA =	5,508	TOTAL GLASS SOLAR =		199,268		
TOTAL GLASS AREA =	5,508	TOTAL GLASS TRANS. =		-278,705		
SKYLIGHT AREA =	0	TOTAL SKYLIGHT SOLAR =		0		
SKYLIGHT AREA =	0	TOTAL SKYLIGHT TRANS =		0		
AREA OF N. WALL =	0	N. WALL LOAD =		-0		
AREA OF S. WALL =	0	S. WALL LOAD =		0		
AREA OF E. WALL =	0	E. WALL LOAD =		0		
AREA OF W. WALL =	0	W. WALL LOAD =		0		
AREA OF NE WALL =	328	NE WALL LOAD =		-4,040		
AREA OF NW WALL =	1,601	NW WALL LOAD =		-19,807		
AREA OF SE WALL =	521	SE WALL LOAD =		-5,477		
AREA OF SW WALL =	3,408	SW WALL LOAD =		-37,798		
TOTAL WALL AREA =	5,858	TOTAL WALL TRANS. =		-67,122		
AREA OF ROOF =	4,870	ROOF LOAD =		-31,676		
AREA ADJ. N.D.T. =	0	LOAD FROM N.D.T. AREA =		0		
EVAP FAN H.P. =	12.21	T. FAN & DUCT GAIN =		39,972		
MISC + INFL SENS =	-51,620	MISC. + INFL SENS. =		-51,620		
VENTILATION CFM =	1,800	O. A. SENSIBLE LOAD =		-180,466		
MISC+INFL LATENT =	1,970	MISC. + INFL LATENT =		1,970		
NUMBER OF PEOPLE =	134	PEOPLE LATENT LOAD =		27,532		
VENTILATION CFM =	1,800	O.A. LATENT LOAD =		0		
TOTAL CFM =	14,220	TOTAL LATENT LOAD =		0		
EFF ROOM SENSIBLE = -120,036		EFF. ROOM LAT. LOAD =		0		
--> GRAND TOTAL LOAD =		-290,565 BTU'S <--				
23. EST. TYPICAL TONS @ -20F. =		-24.21 (OCC.)				
TOT SENSIBLE LOAD = -290,565		TOT LATENT LOAD =		0		
AREA (SQ FT) = 13,430		CFM PER SQ FT =		1.06		
SUPPLY AIR CFM = 14,220						
SPACE DRY BULB DEG.F. = 72						
T. ST. EVAP FAN = 3.00		DEGREES ROTATED = 0				
BYPASS P. ASSUMED IS .1		CEILING RETURN !!!				
NET BLDG. ENVELOPE 'U' FACTOR = 0.27						
MAX. PERIM. LOAD AMBIGUITY = 0.0 TONS.						
CASE CREDITS = 0 / 0 MBH SENS./LAT.						
SUB-CASE RETURN AIR PERCENT = 0						
INTERIOR ZONE SQ. FT. = 6446						